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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

In Reply Refer To:
13410-2007-F-0186

FEB 2 5 2008

Mr. Daniel M. Mathis
Division Administrator
Federal Highway Administration - Washington Division
711 South Capitol Way, Suite 501 Evergreen Plaza
Olympia, Washington 98501-1284

ATTN: Brian Hasselbach

Dear Mr. Mathis:

This document transmits the U.S. Fish and Wildlife Service's Biological Opinion (BO) based on our review of the proposed State Route 522, Cathcart Road Vicinity to U.S. Highway 2 traffic safety and mobility improvement project, Snohomish County, Washington, and its effects on the bull trout (*Salvelinus confluentus*) and designated critical habitat for bull trout in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Your request for initiation of formal consultation, dated January 23, 2007, was received in our office on January 24, 2007. The Federal Highway Administration has provided information in support of "may affect, likely to adversely affect" determinations for bull trout and designated bull trout critical habitat, and a "may affect, not likely to adversely affect" determination for the bald eagle. We concur with these effect determinations. On May 15, 2007, the Service received from your office additional information and initiated formal consultation on the project.

The enclosed BO addresses the proposed action's adverse effects on bull trout and designated bull trout critical habitat and includes mandatory terms and conditions intended to minimize certain adverse effects. If you have any questions regarding the BO or your responsibilities under the Act, please contact Ryan McReynolds at (360) 753-6047 or John Grettenberger at (360) 753-6044, of my staff.

Sincerely,

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:
WSDOT, Northwest Region (G. Davis)
WSDOT, Environmental Services Office (P. Wagner)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

USFWS Log# 13410-2007-F-0186

State Route 522, Cathcart Road Vicinity to U.S. Highway 2 (Widening)

Snohomish County, Washington

Agency:

Federal Highway Administration
Olympia, Washington

Consultation Conducted By:

U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Lacey, Washington

John Grettenberger for
Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

2/25/08
Date

TABLE OF CONTENTS

FIGURES and TABLES

CONSULTATION HISTORY

The Washington State Department of Transportation (WSDOT) and Federal Highway Administration (FHWA) propose to construct safety and mobility improvements along approximately four miles of State Route (SR) 522, between (and including) the existing bridge over the mainstem Snohomish River (Bridge 522/138) and the SR 522 / U.S. Highway 2 (US 2) interchange in Snohomish County, Washington. The project will require a Clean Water Act section 404 permit. Federal funding and issuance of a section 404 permit establish a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(Act).

The U.S. Fish and Wildlife Service (Service) based this Biological Opinion (BO) on the following sources of information: the Biological Assessment (BA), dated December 2006 and received on January 24, 2007; WSDOT and FHWA responses to our requests for additional information (written correspondence received on May 15, 2007); additional technical memoranda received from the WSDOT on July 27, August 14, and September 27, 2007; a field review of the project site; and, various scientific literature and personal communications cited and referenced herein. A complete administrative record of this consultation is on file in the Western Washington Fish and Wildlife Office in Lacey, Washington.

The following timeline summarizes the history of this consultation:

January 24, 2007 – The FHWA submits a BA and request for formal consultation with an effect determination of "may affect, likely to adversely affect" for bull trout (*Salvelinus confluentus*) and designated critical habitat for bull trout; the FHWA also requests informal consultation with an effect determination of "may affect, not likely to adversely affect" for bald eagle (*Haliaeetus leucocephalus*).

March 14, 2007 – The Service requests additional information regarding stormwater design, in-water impact pile driving, proposed fish passage improvements, and related matters relevant to the effect determination for bull trout.

May 15, 2007 – The WSDOT and FHWA provide responses to the Service's requests for additional information via written correspondence; the WSDOT and FHWA modify the Project Description, agreeing to use 24-inch diameter temporary steel piles (rather than 36-inch piles) as a means of minimizing adverse effects associated with in-water impact pile driving operations.

July 27, August 14, and September 27, 2007 – The WSDOT submits additional information (three Technical Memoranda) in support of the preferred stormwater design; this information is submitted in response to questions posed by the National Marine Fisheries Service.

August 8, 2007 – The Service removes the bald eagle from the Federal List of Threatened and Endangered Wildlife, thereby allaying the need to consult informally for the species.

BIOLOGICAL OPINION

Approach to the Jeopardy Analysis

To conduct a jeopardy analysis for the bull trout, we evaluate the following: (1) the *Status of the Species*, which evaluates the bull trout's rangewide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the bull trout in the action area, the factors responsible for that condition, and the conservation role of the action area; (3) the *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and any interrelated or interdependent actions on the bull trout; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

Our analysis considers how the likelihood of survival and recovery of the bull trout in its coterminous United States (U.S.) range may change with implementation of the proposed Federal action. The analysis involves multiple spatial scales, and is predicated on the concept that the fate of individuals affected by the proposed action may influence the persistence of the affected local population(s), core area(s), Interim Recovery Unit(s), and the coterminous U.S. population of the bull trout. Our analysis begins by identifying the probable risks posed to individual bull trout by the proposed action, and then integrates those individual risks to identify consequences to the bull trout populations at the higher scales described above. Our jeopardy determination is based on whether bull trout are likely to experience a reduction in viability at the coterminous U.S. scale, and whether any reduction is likely to be appreciable.

In other words, the effects of the proposed Federal action are evaluated with the aggregate effects of everything that has led to the bull trout's current status and, for non-Federal activities in the action area, those actions likely to affect the bull trout in the future. We then determine if, given the aggregate of all of these effects, implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the bull trout in the wild at the scale of the entire listed species.

Approach to the Destruction or Adverse Modification Analysis

In conducting an analysis of effects to critical habitat, we do not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we rely on the statutory provisions of the Act, using the following analytical framework.

We consider (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of its primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

In accordance with Service policy and guidance, the effects of the proposed Federal action on bull trout critical habitat are evaluated with the aggregate effects of everything that has led to the current status of critical habitat rangewide and, for non-Federal activities in the action area, those actions likely to affect critical habitat in the future. We then determine if, given those aggregate effects, critical habitat rangewide would remain functional (or retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve the intended conservation or recovery role for the species.

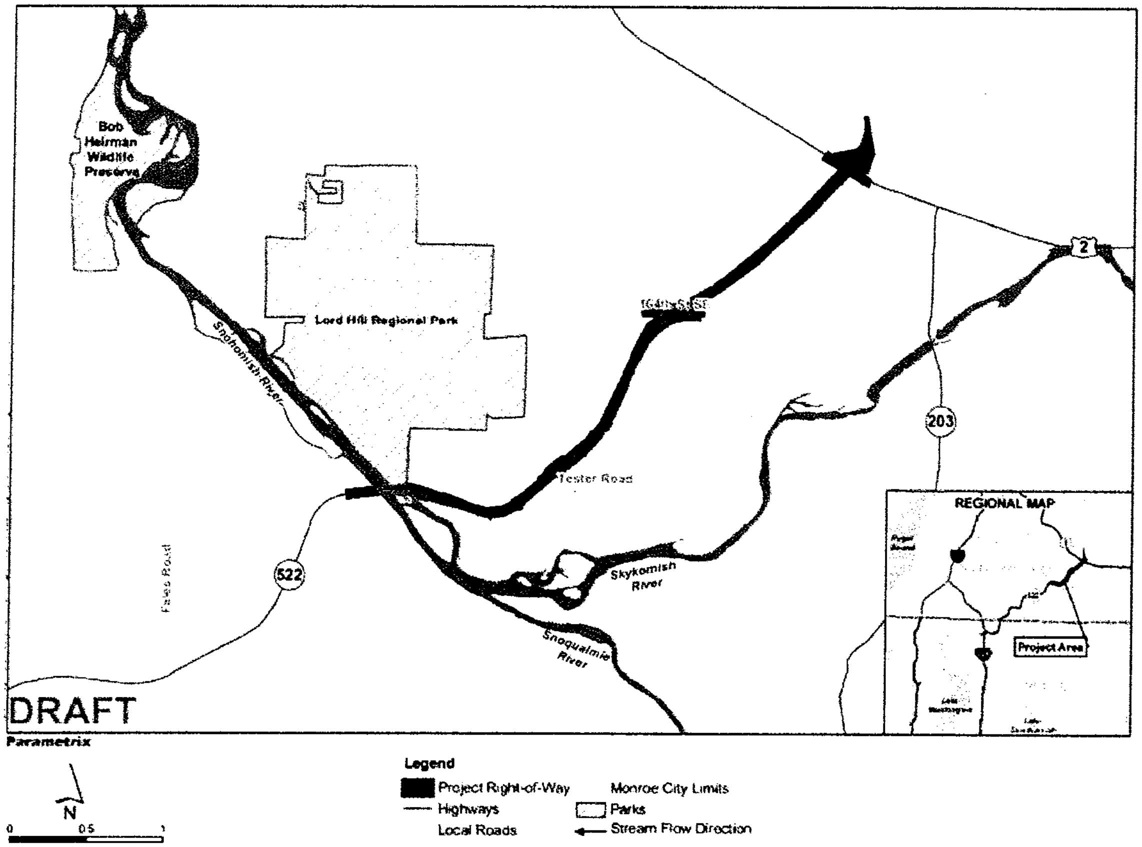
DESCRIPTION OF THE PROPOSED ACTION

The WSDOT and FHWA propose to construct safety and mobility improvements along approximately four miles of SR 522, between (and including) the existing bridge over the mainstem Snohomish River (Bridge 522/138) and the SR 522 / US 2 interchange in Snohomish County, Washington. The project would expand the existing two-lane facility to two lanes in each direction with median separation (4 lanes total) from milepost vicinity 20.4, approximately 1,000 ft west of the Snohomish River crossing, east and north to milepost vicinity 24.7 at the SR 522 / US 2 interchange in the City of Monroe, Washington (Figure 1). For topographical reference, the geographic location is Township 27 North, Range 6 East, Sections 1, 2, 10, 11, 15 and 16. The project is located in Water Resources Inventory Area (WRIA) 7 – Snohomish, within hydraulic unit codes (HUCs) 17110009 (Skykomish) and 17110010 (Snoqualmie).

SR 522 extends approximately 25 miles in a northeasterly direction, from Interstate 405 (between Bothell and Woodinville) to US 2 (in Monroe). SR 522 serves suburban developments in the NE Seattle metro area and unincorporated Snohomish County. The City of Monroe and surrounding parts of unincorporated Snohomish County experienced dramatic rates of growth during the 1990's; rates which have now somewhat moderated during the early 2000's. The City of Monroe is within commuting distance of both the City of Everett (located at a distance of 16 miles) and the NE Seattle metro area. SR 522 is both a popular commuter route and a truck/freight corridor.

The proposed action would expand capacity along existing facilities and modify and improve two interchanges within the incorporated limits of the City of Monroe (i.e., the 164th Street SE/Tester Road surface arterial interchange and SR 522 / US 2 interchange). The action is intended to improve traffic safety and operations, to reduce congestion, and increase capacity to meet current and projected future traffic demands. These portions of SR 522 do not meet current design standards for a "principal arterial highway" and under an Average Daily Traffic (ADT) of approximately 18,000-19,000 vehicles per day (estimated over years 2001 to 2003) the WSDOT

Figure 1. Vicinity map.



has recorded between 24 and 30 accidents along the corridor annually (FHWA 2006). The proposed action will design and construct safety and mobility improvements to meet an estimated ADT of 53,000 or more vehicles per day in the design year (2030).

A 1994 Final Environmental Impact Statement and Record of Decision addressed FHWA's long-term plans to widen more than ten miles of SR 522 from a two-lane facility to a four-lane, divided, full-access controlled freeway. During 2003 the Service consulted with FHWA on the "Stage 2-4" expansion of approximately 3.6 miles of SR 522, from Paradise Lake Road to the Snohomish River Bridge. This formal consultation (USFWS 2003) also addressed design and construction of two interchanges to replace at-grade intersections along the portion of SR 522 immediately west of the Snohomish River crossing (i.e., the Paradise Lake Road and Fales/Echo Lake Road interchanges). The current, proposed action represents one of the final phases, if not the final phase of designing and constructing the long-term safety and mobility improvements originally addressed by the FHWA's 1994 Environmental Impact Statement for the "Woodinville to Monroe" corridor.

Project Elements and Items of Work

The proposed action includes several project elements and items of work. The following are discussed in greater detail by the sub-section that follows: clearing and other activities associated with widening the roadway from two to four lanes; modifications and improvements to the 164th Street SE/Tester Road surface arterial interchange and SR 522 / US 2 interchange; construction of a new two-lane bridge over the Snohomish River; construction and/or replacement of two or more additional bridges over surface roadways; design and construction of permanent stormwater run-off conveyance, treatment and flow control facilities; replacement of two known fish passage barriers (i.e., improperly sized/designed cross culverts) with new structures; and compensatory mitigation for unavoidable wetland/buffer, floodplain, and riparian impacts. These project elements and items of work are described more completely in the BA submitted by FHWA (FHWA 2006). Those descriptions are incorporated here by reference, except where they have been revised or amended as agreed to during the course of consultation and documented in correspondence between the FHWA and the Service.

The proposed project will require approximately 750 working days to construct between 2010 and 2013. The project will require in-water work (below the Ordinary High-Water Mark, OHWM) within the mainstem Snohomish River during an extended work window (July 1 to September 30) for two consecutive construction seasons (2010 and 2011). The project will require in-water work within minor tributaries to the Skykomish River and Cripple Creek (French Creek basin) during the established work window, July 1 to August 31, through at least three consecutive construction seasons (2010 through 2012).

Constructing the project will require large cuts and a limited amount of controlled blasting along western portions of the corridor, and placement of large fills along eastern portions of the corridor. The project will clear and grub the "clear-zone" and side embankments of the existing developed road prism, as well as areas immediately adjacent for the full length of the project corridor, to establish the full width of the widened developed road prism. The project will adhere to seasonal limitations on the amount of clearing and open grading conducted at any one time (WSDOT 2005; Standard Specification 8-01.3(1)). Related activities will include on-site staging, relocation of utilities, and construction of retaining walls, guardrail runs, new and reconfigured traffic signals, area lighting, and intelligent transportation systems (traffic and weather sensory and communications equipment).

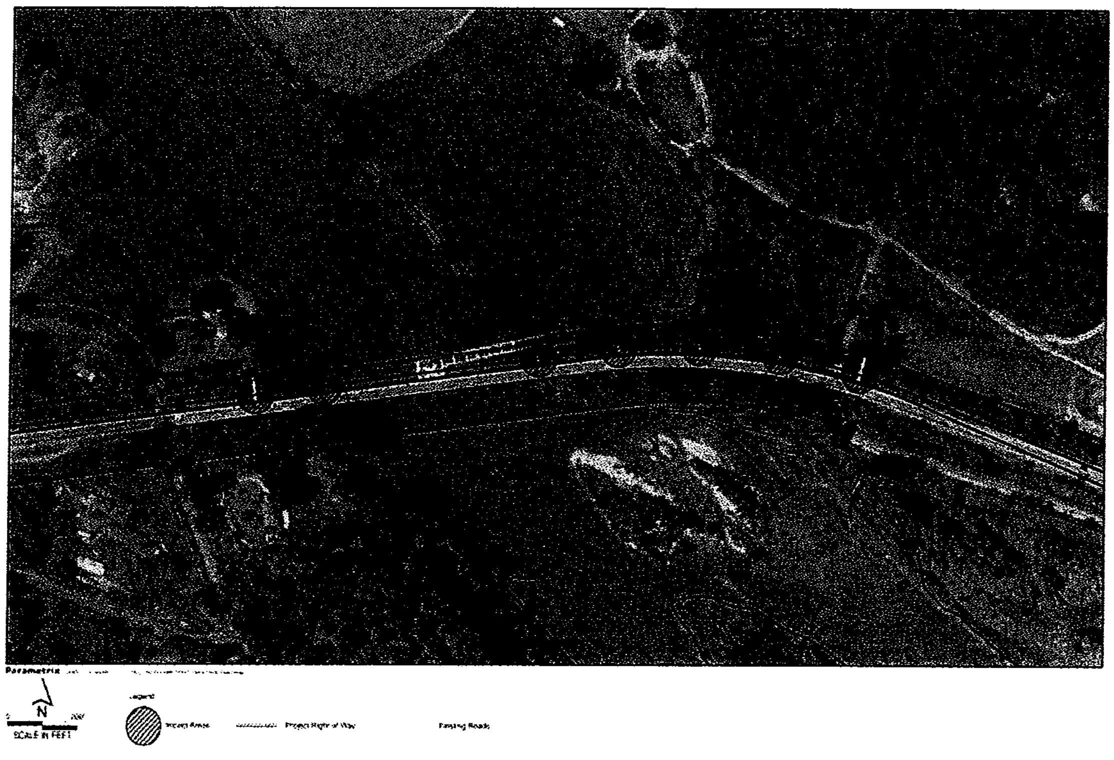
Staging locations have not been specifically identified. The project will mobilize and stage construction from locations outside of sensitive areas (e.g., closed portions of the travel lanes, shoulder, "clear-zone", suitable adjacent properties, etc.), and measures will be taken to prevent impacts to wetlands, waterbodies, and native vegetation. [Note: some project elements cannot be constructed without unavoidably disturbing wetlands, riparian vegetation, and floodplain (e.g., construction of the new bridge over the Snohomish River and replacement of the two known fish passage barriers); these elements are discussed in greater detail below.]

The project will design and construct retaining walls to minimize impacts to wetlands, waterbodies, and floodplain where feasible. Any temporary or permanent walls constructed at or below the OHWM of a waterbody (or associated open-water wetland) will be constructed during the established in-water work window.

The project will reconfigure the existing 164th Street SE/Tester Road surface arterial interchange with widened ramps and a wider (and/or additional) roundabout. The project will substantially reconstruct the SR 522 / US 2 interchange to increase capacity and will construct additional bridges (and/or replace existing bridges) where SR 522 passes over surface roadways. Construction of the proposed interchange improvements will result in unavoidable impacts to portions of two heavily degraded (i.e., ditched and channelized) tributaries to Cripple Creek located within the existing developed interchange areas.

The project will construct a new two-lane bridge over the Snohomish River, located in parallel and downstream of the existing bridge (Bridge 522/138). The new bridge will consist of two 300-foot plus spans, with a cast-in-place superstructure supported on steel girders and eight cast-in-place pier columns and footings. One pier (Pier 3) will be constructed mid-channel within the mainstem Snohomish River, and four additional piers (Piers 4-7) will be constructed within the Snohomish-Skykomish River 100-year floodplain extending eastward from the right bank (Figure 2).

Figure 2. New bridge pier locations, temporary haul road, and work trestle.



Construction of the pier columns and footings will require access to the floodplain below the existing bridge and a temporary work trestle constructed from the right bank out into the middle (or near the middle) of the mainstem Snohomish River. The project will construct a temporary haul road(s) extending approximately 1,200 ft west and south from Tester Road, a surface street which passes below the existing bridge near its east abutment (Figure 2). The project proposes to maintain and "over-winter" the haul road(s) for use during multiple seasons of construction (2010, 2011, and perhaps during additional seasons). At completion of all construction activities within the floodplain, the project will remove any temporary fills associated with the haul road, till any compacted soils (as necessary and appropriate), and restore native woody and herbaceous vegetation according to an approved restoration plan.

The project will require in-water work within the mainstem Snohomish River during two consecutive construction seasons (2010 and 2011). This work includes the placement and subsequent removal of approximately 135 temporary steel piles during each of two seasons (for the temporary work trestle), the installation of temporary steel casing and drilling of shafts for the mid-channel pier, pouring of the mid-channel pier footing and column, and any related activities. The project will utilize 24-inch diameter temporary steel piles, installed with an impact hammer and noise attenuation device (i.e., confined bubble curtain or functional equivalent) and removed at the end of each of the two in-water work windows with a vibratory hammer. Removal and rebuilding of the temporary work trestle has been deemed necessary because of the amount of debris conveyed by the channel during winter months. All in-water work conducted within the mainstem Snohomish River will be completed during the approved in-water work window (July 1 to September 30), and only pouring of the Pier 3 footing/column and removal of the temporary work trestle and piles will be permitted after August 31 of each season (FHWA 2006). All impact pile driving within the mainstem Snohomish River will be conducted between July 1 and August 31. Impact pile driving is an intermittent activity and the project proponent expects the project will install 1-5 piles per day. Impact pile driving will be conducted intermittently on 30 or more working days during each of two construction seasons (2010 and 2011).

In addition to the in-water work necessary to construct the new bridge over the Snohomish River, this project element will also require extensive work conducted directly over the channel and within the floodplain. This work includes preparation and painting of the steel girders and supportive members, false and formwork for the bridge superstructure, and construction of the shafts, footings, and columns associated with the seven bridge piers and abutments not located below the OHWM. These items of work may be conducted at any time of year and current construction sequencing has them tentatively scheduled for July through December 2010 and July 2011 through February 2012 (FHWA 2006). Metalwork, preparation and painting will follow applicable WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-07) and all terms and conditions from the Hydraulic Project Approval (HPA), or General HPA, issued for the project by the Washington State Department of Fish and Wildlife (WDFW). Concrete form and falsework, weather and temperature limits, curing procedures and other aspects of cast-in-place bridge deck and column construction will follow WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-02).

The project will design and construct permanent stormwater run-off conveyance and treatment facilities for all of the new and existing pollution-generating impervious surface (PGIS) within the project limits, excluding the impervious surface associated with the existing bridge over the Snohomish River (Bridge 522/138). The current design calls for approximately eight wetpool/constructed stormwater treatment wetlands (Figures 3-5). These facilities will provide "enhanced" treatment for stormwater run-off from impervious surface located in each of the six threshold discharge areas (TDAs) along the project corridor. The project will provide "enhanced" treatment plus oil control for the impervious surface located within the SR 522 / US 2 interchange (FHWA 2006).

Figure 3. Plan sheet depicting TDAs and location of stormwater facilities.

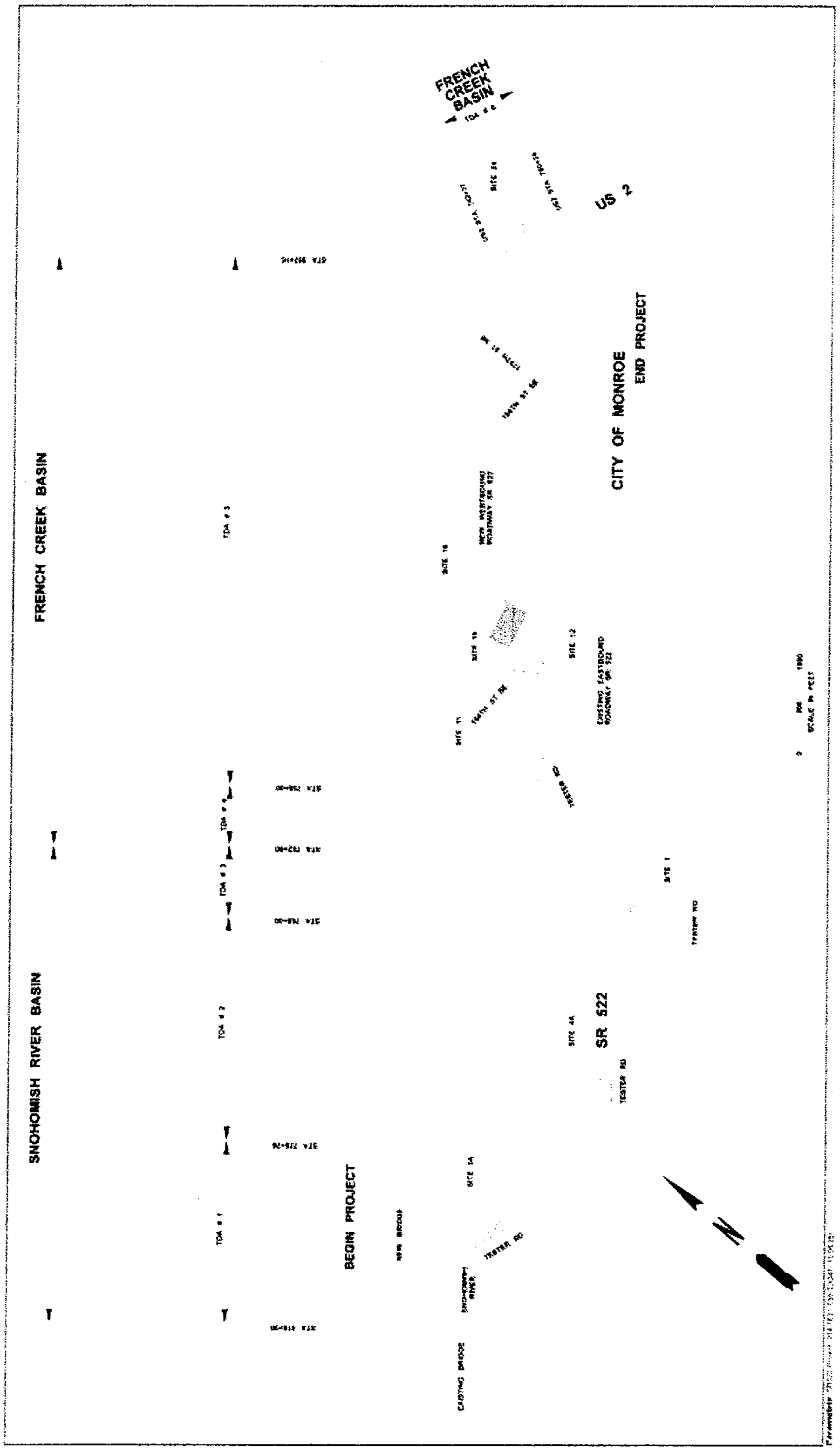


Figure 4. Aerial photo of corridor stormwater facilities (western portion).

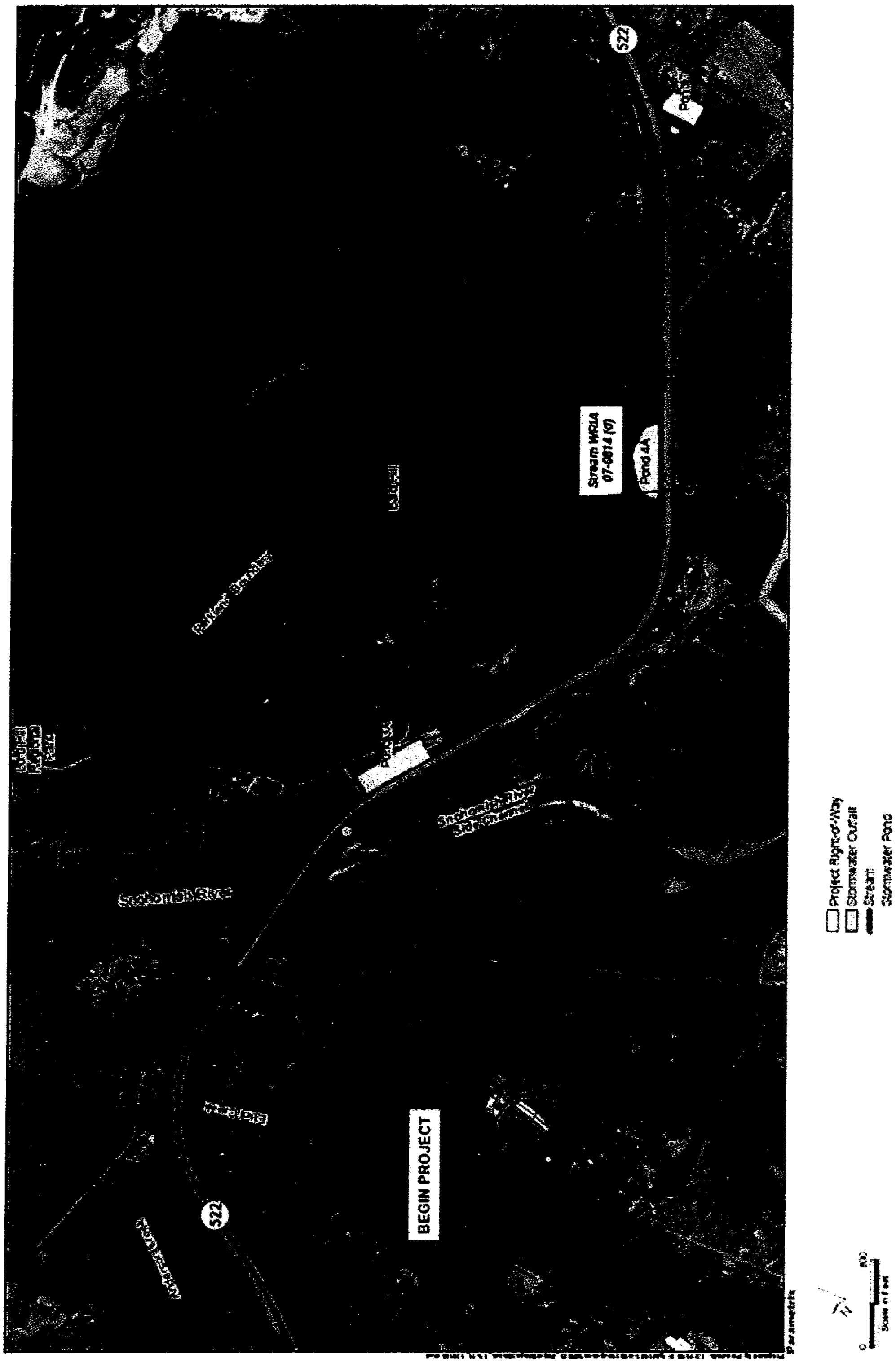
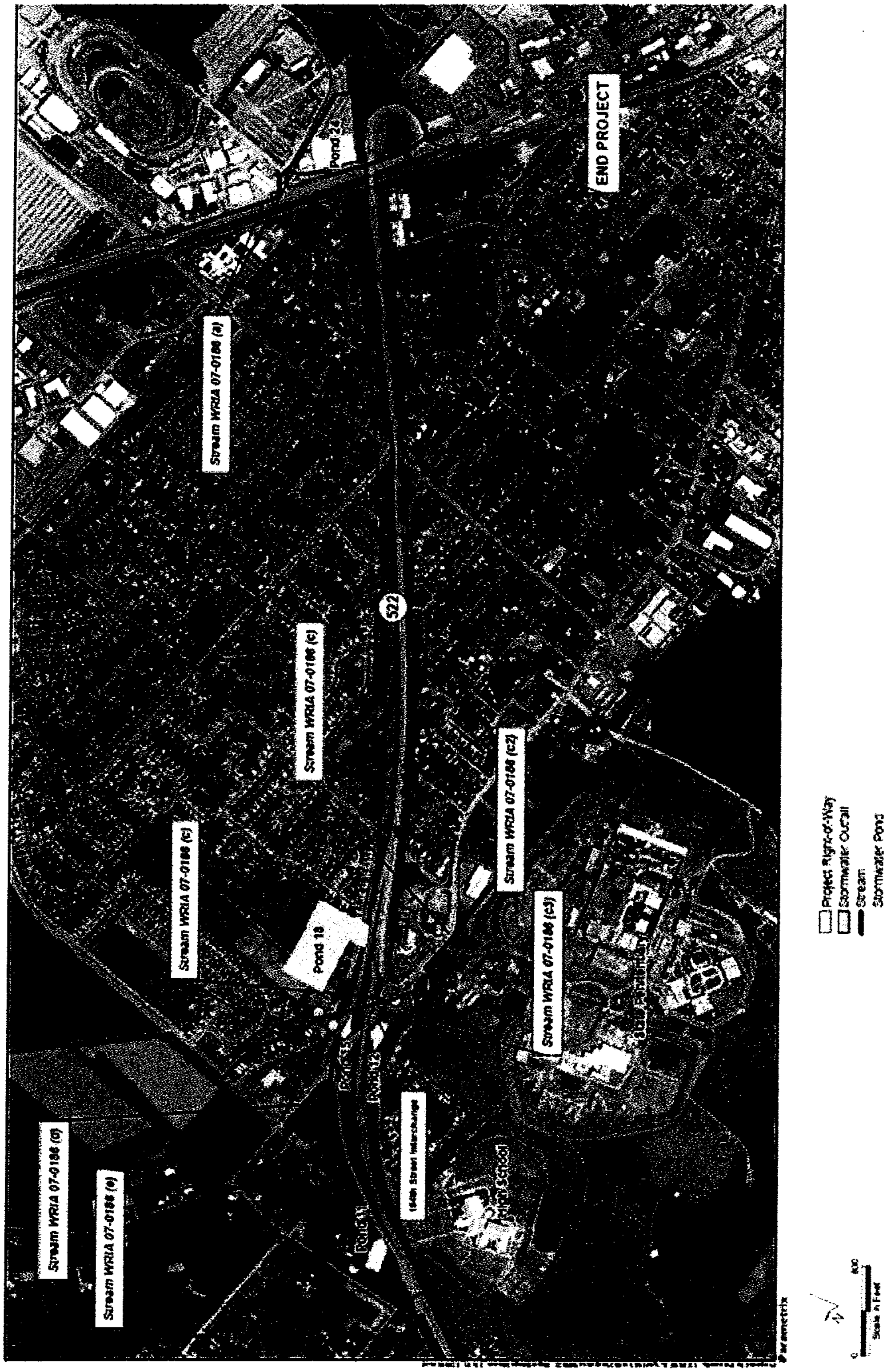


Figure 5. Aerial photo of corridor stormwater facilities (eastern portion).



The project proposes to construct flow control facilities (i.e., wetpools/constructed wetlands designed for additional storage capacity) to detain and moderate peak stormwater flows from four of the six TDAs (TDAs 3-6). The project will seek flow control exemptions for direct discharge of treated stormwater from two TDAs (TDAs 1 and 2). If permitted, these exemptions would allow the project to design and construct smaller facilities in TDAs 1 and 2, thereby reducing their physical "footprint" and associated direct impacts to wetland, floodplain, and buffer. The project proposes to construct and operate for the life of the project more than six new stormwater outfalls (points of discharge to adjacent receiving waterbodies). Additional details regarding stormwater design and performance are provided in a later sub-section that follows (Description of the Proposed Action, Stormwater Design).

The proposed project would replace two known partial fish passage barriers (24-inch diameter corrugated metal cross culverts) that convey a minor tributary to the Skykomish River below SR 522. The project would improve these crossings by replacing the existing cross culverts with an approximately 8-foot high, by 28-foot wide, by 180-foot long bottomless structure (combined fish passage and wildlife crossing structure) and with an approximately 96-inch diameter (by 165-foot long) countersunk corrugated metal cross culvert. Each of the proposed replacement structures would be designed and built to meet all relevant and applicable Washington Administrative Code (WAC) criteria for fish passage (WAC 220-110-070).

Work to replace the partial fish passage barriers would be completed during the established in-water work window (July 1 to August 31) during the 2010 and 2012 construction seasons. The existing structures would serve as a bypass for streamflow, allowing the project to install the new structures in parallel (with minimal realignment) and in a manner that accommodates construction of the widened road prism and related traffic shifts. The project will use WSDOT's established protocols for safely capturing, relocating, and excluding fish from the in-water work area and will implement erosion control best management practices (BMPs) and dewatering procedures to ensure compliance with the Washington State Department of Ecology (WDOE) / WSDOT *Implementing Agreement for Compliance with State Surface Water Quality Standards* (WDOE / WSDOT 1998). When replacing these structures, the project will limit disturbance to the bed, banks, and native vegetation to the full extent practicable, will utilize "soft", bioengineered bank treatments incorporating large woody debris (LWD) in deference over heavy rock armored treatments, and will include design specifications (WSDOT 2007a; Standard Specification 9-03.11) as necessary to seal reconstructed portions of the channel bed (including the bed constructed within/below the bottomless structure) and prevent excessive flow below grade.

Plans for on-site and off-site compensatory mitigation for the project's unavoidable wetland/ buffer, floodplain, and riparian impacts are at a preliminary stage of development and it is not possible at this time to identify with certainty where these actions will occur. The project will replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to ratios established by the U.S. Army Corps of Engineers (USACE), WDOE, Snohomish County, and the City of Monroe, Washington. The project will comply with all terms and conditions from the Clean Water Act section 404 permit issued for the project and will satisfy the most stringent requirements from critical area ordinances and regulations administered by these other jurisdictions (FHWA 2006).

At the time of this BO's preparation, the WSDOT and FHWA expect that compensatory mitigation will be a combination of on-site and off-site enhancement and restoration activities. Most of the project's unavoidable impacts to wetland/buffer, floodplain, and riparian functions will be mitigated off-site. The WSDOT has identified what it believes are the top-two candidate "in-basin" and watershed opportunities, both of which are privately owned, permitted, and developed mitigation banks located within basin (M. MacDonald pers. comm. 2007):

- Skykomish Habitat Mitigation Bank (Skykomish Habitat, LLC), located at 18016 177th Ave. SE, Monroe, Washington 98272; and,

- Snohomish Basin Mitigation Bank (Habitat Bank, LLC), located at 24219 High Bridge Rd., Monroe, Washington 98272.

Both of these facilities are already constructed, or partially constructed, and nearly ready to begin selling/offering credits. The issuance of credits will follow the processes detailed in the mitigation bank instruments approved by WDOE and USACE. Each of these actions has been the subject of an earlier informal consultation with the Service (Skykomish Habitat, LLC – FWS Ref. No. 1-3-05-I-0426 / Cross Ref. 1-3-05-IC-0427; Habitat Bank, LLC – FWS Ref. No. 1-3-05-I-0276).

Construction Impacts and Summary of Quantities

Construction of the project will require approximately 138,000 cubic yards of cut (material removal), mostly along western portions of the corridor, and approximately 400,000 cubic yards of fill, mostly along eastern portions of the corridor. At one location, approximately 0.6 mile east of the Snohomish River crossing, construction of the project will require controlled blasting conducted intermittently on as many as 10 working days. The project will place and detonate approximately 80 individual charges per day. Current construction sequencing has controlled blasting operations tentatively scheduled for August 16 to October 30, 2010 (FHWA 2006).

The project will clear and grub or otherwise impact more than 40 acres of native vegetation when constructing the widened developed road prism. This includes more than 1,000 deciduous and coniferous trees within and immediately adjacent to the "clear-zone" of the existing developed road prism. Much of this area will be permanently converted to intensively-managed uses associated with the widened corridor (i.e., travel lanes and shoulders, ramps, structures, utility corridors, stormwater and drainage facilities, etc.). Any areas disturbed on a temporary basis will be permanently stabilized in a manner consistent with the WSDOT's Roadside Classification Plan (WSDOT 1996).

Gaining access to the Snohomish-Skykomish floodplain for the purpose of constructing new bridge pier footings and columns will require constructing and maintaining an approximately 0.8 acre temporary haul road(s). The project will also clear approximately 7,800 square feet of native floodplain vegetation when constructing each of the seven new "upland" bridge piers (approximately 1.25 acres in total). The project will clear from the floodplain below and adjacent to the existing bridge over the Snohomish River between 50 and 100 deciduous trees in excess of 6 inches diameter-at-breast-height, including 10 to 20 large black cottonwoods (*Populus balsamifera*). At completion of all construction activities within the floodplain, the project will remove any temporary fills associated with the haul road(s), till any compacted soils, and restore native woody and herbaceous vegetation according to an engineer-approved restoration plan.

The proposed action is expected to fill or otherwise permanently degrade approximately 6.5 acres of Category III and Category IV wetland and approximately 10.2 acres of wetland buffer along the project corridor. In addition, the proposed action will result in permanent and temporary impacts to approximately 3.7 acres and 2.6 acres of stream/riparian buffer, respectively. The project will replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to approved ratios. Plans for on-site and off-site compensatory mitigation are incomplete at this time.

The project will construct an approximately 315-foot long, by 30-foot wide, temporary work trestle from the right bank out into the middle (or near the middle) of the mainstem Snohomish River. The project will place and then remove approximately 135 temporary steel piles during each of two seasons, resulting in direct, temporary impacts to approximately 500 square feet of substrate below the OHWM. For the duration of the extended in-water work window (July 1 to September 30) during each of two consecutive construction seasons (2010 and 2011), over-water portions of the work trestle are expected to temporarily disturb approximately 9,500 square feet (0.22 acre) of instream habitat below the OHWM of the mainstem Snohomish River.

The project will construct a single mid-channel pier footing and column (Pier 3), resulting in permanent impacts to approximately 80 square feet of substrate below the OHWM of the mainstem Snohomish River. The new, permanent mid-channel pier will be constructed within the "hydraulic shadow" of the existing mid-channel pier and is therefore expected to have a negligible effect on channel hydraulics, bedload/LWD transport, and channel formation.

The project will have direct, permanent impacts to the bed and banks of two, unnamed minor tributaries to the Skykomish River and two, unnamed minor tributaries to Cripple Creek (at least 7 locations in total). The project will extend cross culverts, replacing approximately 550 linear feet of open channel with closed conveyance, at three locations where there is little or no fish habitat located upstream of the crossings [identified in the BA as "07-0814(e)", "07-0814(c)", "07-0186(d)"].

The proposed improvements to the SR 522 / US 2 interchange will require realigning and reconstructing approximately 2,100 linear feet of open channel along heavily degraded portions of a minor tributary to Cripple Creek ["07-0186(a)/(b)"]. The project proponent expects there will be no net loss of open channel at these locations. The project will stabilize and restore the realigned banks and associated buffer with native woody and herbaceous plantings.

Where replacement of the two partial fish passage barriers is planned ["07-0814(a)/(b)"], the project will limit disturbance to the bed, banks, and native vegetation by employing a vertical headwall and "soft", bioengineered bank treatments with LWD in deference over heavy rock armored treatments. Constructing the new combined fish passage and wildlife crossing structure

["07-0814(a)"] will require realigning and reconstructing approximately 50 linear feet of channel both upstream and downstream of the existing cross culvert. The project will place approximately 125 linear feet of open channel within/below the improved, slightly lengthened fish passage structures. Both structures will be designed and built to meet all relevant and applicable Washington State requirements for fish passage.

Plans for on-site and off-site compensatory mitigation are at a preliminary stage of development and it is not possible at this time to identify with certainty where these actions will occur. Most of the project's unavoidable impacts to wetland/buffer, floodplain, and riparian functions will be mitigated off-site. The WSDOT has identified two privately owned and developed mitigation banks, located within basin, where the project may purchase credits. Actions taken at these banks have been the subject of earlier informal consultations with the Service (FWS Ref. No. 1-3-05-I-0426 / Cross Ref. 1-3-05-IC-0427; FWS Ref. No. 1-3-05-I-0276).

Stormwater Design

At completion, the proposed action would create approximately 27.6 acres of new PGIS (FHWA 2006). This represents an approximately 85 percent increase to the amount of existing PGIS already present along the project corridor (32.7 acres). At present, run-off from little or none of the existing PGIS receives treatment for quality prior to discharge. Roadside ditches and other open conveyances currently provide only a limited amount of passive infiltration and biofiltration (i.e., removal of solids).

The project will design and construct permanent stormwater conveyance and treatment facilities to provide "enhanced" treatment for run-off from an area equivalent to 100 percent of the new and existing PGIS (approximately 60.3 acres). Conditions are not conducive to infiltration along the project corridor, so the project will construct more than six new stormwater outfalls (Figures 3-5). These outfalls will be operated for the life of the project. Table 1 reports post-project PGIS and identifies the receiving waterbody for each of the six TDAs along the project corridor.

At completion, the project will directly discharge treated stormwater runoff (i.e., without flow control) to a side-channel of the Skykomish River in the immediate vicinity of Bridge 522/138, and to a minor tributary to the Skykomish River ["07-0814(d)"] located approximately 5,000 ft "upstream" of this same side-channel. The project will also discharge treated and detained (i.e., flow controlled) runoff to another small tributary to the Skykomish River ["07-0012(a)"] and to two, heavily degraded minor tributaries to Cripple Creek (French Creek basin). The proposed flow control facilities, including the large facilities proposed for TDAs 3-6, are expected to fully infiltrate runoff from most storm events and to discharge to the "receiving waterbody" on only an infrequent basis (i.e., events exceeding the 6-month storm event) (FHWA 2006).

Table 1. Post-project PGIS and receiving waterbody (by TDA).

TDA	Site/Pond Identifier	Post-Project New & Existing PGIS (Acres; % of Total)	Receiving Waterbody
1	3A	11.1 (18%)	Skykomish River (side-channel)
2	4A	11.0 (18%)	07-0814(d), Tributary to Skykomish
3	7	2.7 (5%)	07-0012(a), Tributary to Skykomish
4	11	1.1 (2%)	07-0186(e), Tributary to Cripple Creek
5	12, 15, 18	28.5 (47%)	07-0186(c), Tributary to Cripple Creek
6	24	5.9 (10%)	07-0186(b), Tributary to Cripple Creek

The WSDOT is currently refining hydraulic analyses to support requested flow control exemptions for direct discharge of treated stormwater in TDAs 1 and 2. These analyses are preliminary, but suggest that storm flows that are directly discharged will not cause or contribute to bed or bank erosion along the reaches immediately downstream of the proposed "treatment-only" facilities (Ponds 3A and 4A) (FHWA 2006).

The proposed action includes a stormwater design expected to achieve significant reductions in pollutant loading and treated effluent/discharge concentration for contaminants of concern (FHWA 2006). Compared to pre-project pollutant loadings, post-project pollutant loadings of total suspended solids (TSS) and total zinc (Zn) will be *reduced* in each of the TDAs. Total copper (Cu) loadings will be *reduced* in each TDA, *except* TDA 1. Because dissolved metals are difficult to remove by conventional methods, post-project dissolved Zn loadings will be *increased* in both TDAs 1 and 2, and dissolved Cu loadings will be *increased* in each of the TDAs *except* TDA 6.

In TDA 1 post-project annual loadings of dissolved Zn, total Cu, and dissolved Cu are expected to *increase* by approximately 73 percent (from 1.28 to 2.22 lbs.), by approximately 12.5 percent (from 0.64 to 0.72 lbs.), and by approximately 130 percent (from 0.17 to 0.39 lbs.) respectively. In TDA 2 post-project annual loadings of dissolved Zn and dissolved Cu are expected to *increase* by approximately 3.7 percent (from 2.12 to 2.20 lbs), and by approximately 39 percent (from 0.28 to 0.39 lbs.) respectively. Post-project annual loadings of dissolved Cu are expected to increase by approximately 29 percent (from 0.07 to 0.09 lbs.) in TDA 3, and by approximately 5.3 percent (from 0.95 to 1.0 lbs.) in TDA 5.

Applying assumptions from the *Interim Guidance* (WSDOT 2006a), the proposed action is expected to achieve reductions in treated effluent/discharge concentration. Table 2 reports pre-project, post-project, and net change in treated effluent/discharge concentrations for select stormwater pollutants.

Table 2. Treated stormwater effluent discharge concentrations (WSDOT 2006a).

Stormwater Pollutant / Contaminant of Concern	Pre-Project Concentration	Post-Project Concentration	Net Change
Total Suspended Solids (TSS)	93 mg/L	6.4 mg/L	- 86.6 mg/L
Total Zinc	174 μg/L	40 μg/L	- 134 μg/L
Dissolved Zinc	62 μg/L	27 μg/L	- 35 μg/L
Total Copper	31 μg/L	7 μg/L	- 24 μg/L
Dissolved Copper	7.6 μg/L	5.0 μg/L	- 2.6 μg/L

The project may construct an energy dissipater (i.e., lightly armored bank) at each of the proposed outfall locations. These structures will disturb and/or replace less than 5,000 square feet of bank vegetation in total, and will function to slow discharges and minimize bed and bank erosion.

Conservation Measures

The proposed project would implement conservation measures, including but not limited to the following, to further avoid and minimize impacts associated with construction:

- The project will implement an Engineer-approved Temporary Erosion and Sediment Control Plan and Stormwater Site Plan. The project will select, design, install, maintain and adjust Temporary Erosion and Sediment Control structural and operational BMPs according to WSDOT Standard Specifications. The project will take appropriate measures to stabilize construction entrances and protect temporary stockpiles.

- As one of the first orders of work, the project will install high-visibility construction fencing to avoid unintended impacts to sensitive areas.

- The project will implement an Engineer-approved Spill Prevention, Control and Countermeasures (SPCC) Plan to guard against the release of any harmful pollutant or product. A current copy of the approved SPCC plan will be maintained on-site for the duration of the project and no work or staging in advance of work will commence prior to implementing the plan. The approved SPCC Plan will provide site- and project-specific details identifying potential sources of pollutants, exposure pathways, spill response protocols, protocols for routine inspection fueling and maintenance of equipment, preventative and protective equipment and materials, reporting protocols and other information according to WSDOT Standard Specifications.

- The project will fully comply with all terms and conditions from the WDOE / WSDOT *Implementing Agreement for Compliance with State Surface Water Quality Standards* (WDOE / WSDOT 1998), or with all terms and conditions from a Temporary Water Quality Modification issued by the WDOE.

- The project will monitor for exceedances of the State of Washington aquatic life turbidity criteria, 5 nephelometric turbidity units (NTU) over background when less than 50 NTU (10 percent increase over background when more than 50 NTU). The project will monitor surface water quality while conducting any and all activities that pose a risk of introducing sediments to adjacent waterbodies. Trained staff shall collect background (upstream) and downstream measures of turbidity during the course of in-water work and shall have the authority to take all measures necessary, including temporary cessation of work, to ensure compliance with turbidity criteria at the downstream extent of the allowed mixing zone.

- The project will contain, treat and dispose of wash water and turbid dewater to prevent discharge of pollutants to waters of the State (including wetlands). Any sediment-laden wastewater produced by the project will receive treatment prior to discharge.

- Metalwork, preparation and painting will follow applicable WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-07). Concrete form and falsework, weather and temperature limits, curing procedures and other aspects of cast-in-place bridge deck and column construction will follow WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-02). The project will take measures to ensure all wet or curing concrete, concrete equipment washout and wash water is prevented from entering waters of the State (including wetlands). [<u>Note</u>: WSDOT Standard Specifications and the WDOE / WSDOT *Implementing Agreement for Compliance with State Surface Water Quality Standards* do provide for the testing of waters in contact with uncured concrete and their proper handling and/or disposal, including discharge within allowable limits.]

- The project will adhere to seasonal limitations on the amount of clearing and open grading conducted at any one time (WSDOT 2005; Standard Specification 8-01.3(1)).

- The project will mobilize and stage construction from locations outside of sensitive areas and measures will be taken to prevent unintended impacts to wetlands, waterbodies, and native vegetation. [<u>Note</u>: some project elements cannot be constructed without unavoidably disturbing wetlands, riparian vegetation, and floodplain.]

- Any areas disturbed on a temporary basis will be permanently stabilized in a manner consistent with the WSDOT's Roadside Classification Plan (WSDOT 1996). The project will remove any temporary fills, including fills associated with the temporary haul road(s), will till any compacted soils, and restore native woody and herbaceous vegetation according to an Engineer-approved restoration or planting plan. Where feasible, the project will use geotextile fabric to facilitate removal of temporary fills.

- The project will limit disturbance to the bed, banks, and native vegetation of adjacent waterbodies to the extent practicable and will stabilize and restore these areas (and associated buffer) with native woody and herbaceous plantings, employing where feasible bioengineered bank treatments with LWD in deference over heavy rock armored treatments.

- The project will comply with all terms and conditions from the HPA (and/or General HPA), Clean Water Act section 404 and shoreline permits issued for the project by the Washington Department of Fish and Wildlife (WDFW), USACE, and Snohomish County (or WDOE).

- All in-water work (work below the OHWM) will be completed during the approved in-water work windows: mainstem Snohomish River (July 1 – September 30), minor tributaries to Skykomish River and Cripple Creek (July 1 – August 31). All impact pile driving within the mainstem Snohomish River will be conducted between July 1 and August 31.

- Any temporary or permanent walls constructed at or below the OHWM of a waterbody (or associated open-water wetland) will be constructed during the approved in-water work window.

- All in-water impact pile driving will be conducted with the use of a noise attenuation device (i.e., confined bubble curtain or functional equivalent).

- When conducting work below the OHWM, the project will implement standard WSDOT protocols for safely capturing, relocating, and excluding fish life from the in-water work area. In the event fish are observed dying or in distress, the project will cease any and all activities that may exacerbate conditions and take remedial actions as necessary. Any pumps placed within the wetted channel shall be screened to avoid entraining or impinging fish or other aquatic life. The project will use dewatering procedures designed to limit suspension of sediments and resulting downstream turbidity. [Note: because of practical constraints, the project does not propose to dewater or divert flow, to capture, remove, or exclude fish life when conducting in-water work below the OHWM of the mainstem Snohomish River.]

- The project will correct two deficient fish passage structures, replacing two undersized corrugated metal cross culverts with new structures designed and built to meet all relevant and applicable WAC criteria for fish passage (WAC 220-110-070). The approved design for these structures shall include specifications, as necessary, to seal reconstructed portions of the channel bed and prevent excessive flow below grade.

- All materials placed below the OHWM will be clean and free of contaminants. The project will, to the extent practicable, remove excess dirt and sediment prior to placing LWD within any wetted channel.

- The project will select for use in bioengineered bank treatments only coniferous LWD with a minimum stem diameter of 18 inches. To the extent practicable, the project will embed placed LWD by two-thirds of the stem length and will use rock ballast in preference over cabled "dead man" or earth anchors. Any placed LWD will be installed at or near the low-flow waterline to optimize function as energy diffusers and habitat enhancement.

- The project will replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to ratios established by USACE, WDOE, Snohomish County, and the City of Monroe, Washington. The project will satisfy the most stringent requirements from the various permits issued for the project, from critical area ordinances and regulations administered by these jurisdictions (FHWA 2006).

CONCURRENCE FOR BALD EAGLE

The FHWA has provided information in support of a "may affect, not likely to adversely affect" determination for the bald eagle (*Haliaeetus leucocephalus*). However, effective August 8, 2007, the Service has formally removed the species from the Federal List of Threatened and Endangered Wildlife. Because the proposed action would be implemented on or after that date, consultation under section 7(a)2 of the Act is not required.

The Service has yet to establish the specific requirements and procedures for issuance of permits pursuant to the Bald and Golden Eagle Protection Act. However, all available information suggests any temporary effects to bald eagle perching, foraging, nesting and wintering behaviors resulting from exposure to construction activities will be insignificant and no active nests or territories will be affected by construction or operation of the proposed highway improvements. At this time the Service expects the proposed action will not require issuance of a permit or approval pursuant to the Bald and Golden Eagle Protection Act.

STATUS OF THE SPECIES (Bull Trout; Coterminous Range)

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997).

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: 1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002; 2004a, b). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the services draft recovery plans for the bull trout (USFWS 2002; 2004a,b).

The conservation needs of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002; 2004a,b) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002; 2004a,b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002; 2004a,b).

Jarbidge River Interim Recovery Unit

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004a). The draft bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004a).

Klamath River Interim Recovery Unit

This interim recovery unit currently contains 3 core areas and 7 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002). The draft Klamath River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the 3 core areas (USFWS 2002).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game in litt. 1995). The draft Columbia River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, two are at low risk, and two are at unknown risk (USFWS 2005).

Coastal-Puget Sound Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002). Currently, bull trout are widely distributed in the St. Mary River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002). The draft St Mary Belly bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989; Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Pratt 1985; Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Gilpin, *in litt.* 1997; Rieman et al. 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Spruell et al. 1999; Rieman and McIntyre 1993). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat, as these fish are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Baxter et al. 1997; Rieman et al. 1997). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (McPhail and Murray 1979; Goetz 1989; Buchanan and Gregory 1997). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, (Dunham et al. 2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart Gamett, U.S. Forest Service, pers. comm. 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Frissell 1993; Goetz et al. 2004; Brenkman and Corbett 2005). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Subadult and adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Brown 1994; Donald and Alger 1993). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and Van Tassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (WDFW et al. 1997; Goetz et al. 2004).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model;" Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005; Goetz et al. 2004).

Changes in Status of the Coastal-Puget Sound Interim Recovery Unit

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCPs) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August, 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

STATUS OF CRITICAL HABITAT (Bull Trout; Coterminous Range)

This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

Legal Status

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on September 26, 2005 (70 FR 56212); the rule became effective on October 26, 2005. The scope of the designation involved the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units). Rangewide, the Service designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat (Table 3).

Although critical habitat has been designated across a wide area, some critical habitat segments were excluded in the final designation based on a careful balancing of the benefits of inclusion versus the benefits of exclusion (see Section 3(5)(A) and Exclusions under Section 4(b)(2) in the final rule). This balancing process resulted in all proposed critical habitat being excluded in 9 proposed critical habitat units: Unit 7 (Odell Lake), Unit 8 (John Day River Basin), Unit 15 (Clearwater River Basin), Unit 16 (Salmon River Basin), Unit 17 (Southwest Idaho River Basins), Unit 18 (Little Lost River), Unit 21 (Upper Columbia River), Unit 24 (Columbia River), and Unit 26 (Jarbidge River Basin). The remaining 20 proposed critical habitat units were designated in the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation.

Table 3. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by State.

	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	294	474	50,627	20,488
Montana	1,058	1,703	31,916	12,916
Oregon	939	1,511	27,322	11,057
Oregon/Idaho	17	27		
Washington	1,519	2,445	33,353	13,497
Washington (marine)	985	1,585		

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Critical habitat units generally encompass one or more core areas and may include foraging, migration, and overwintering (FMO) areas, outside of core areas, that are important to the survival and recovery of bull trout.

Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support core areas which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993, MBTSG 1998); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993, Hard 1995, Healey and Prince 1995, MBTSG 1998); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993, Hard 1995 MBTSG 1998, Rieman and Allendorf 2001).

The Olympic Peninsula and Puget Sound Critical Habitat Units are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound bull trout population. These critical habitat units contain nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Note that only PCEs 1, 6, 7, and 8 apply to marine nearshore waters identified as critical habitat; and all except PCE 3 apply to FMO habitat identified as critical habitat.

The PCEs are as follows:

(1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

(2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.

(3) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.

(4) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

(5) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

(6) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

(7) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

(8) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

In freshwater habitat, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. For designated lakes, the lateral extent of critical habitat is defined by the perimeter of the water body as mapped on standard 1:24,000 scale topographic maps.

In marine habitat, critical habitat includes the inshore extent of marine nearshore areas between mean lower low-water and minus 10 meters (m) mean higher high-water, including tidally influenced freshwater heads of estuaries. This refers to the area between the average of all lower low-water heights and all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore areas is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) relative to the mean lower low-water.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212, FWS 2004). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments.

Current Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat.

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Rieman and McIntyre 1993, Dunham and Rieman 1999); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989; MBTSG 1998); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, Rieman et al. 2006); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

ENVIRONMENTAL BASELINE (Bull Trout and Designated Critical Habitat)

Regulations implementing the Act (50 CFR section 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Description of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR section 402.02). As such, the action area includes the extent of the physical, biotic, and chemical effects of the action on the environment.

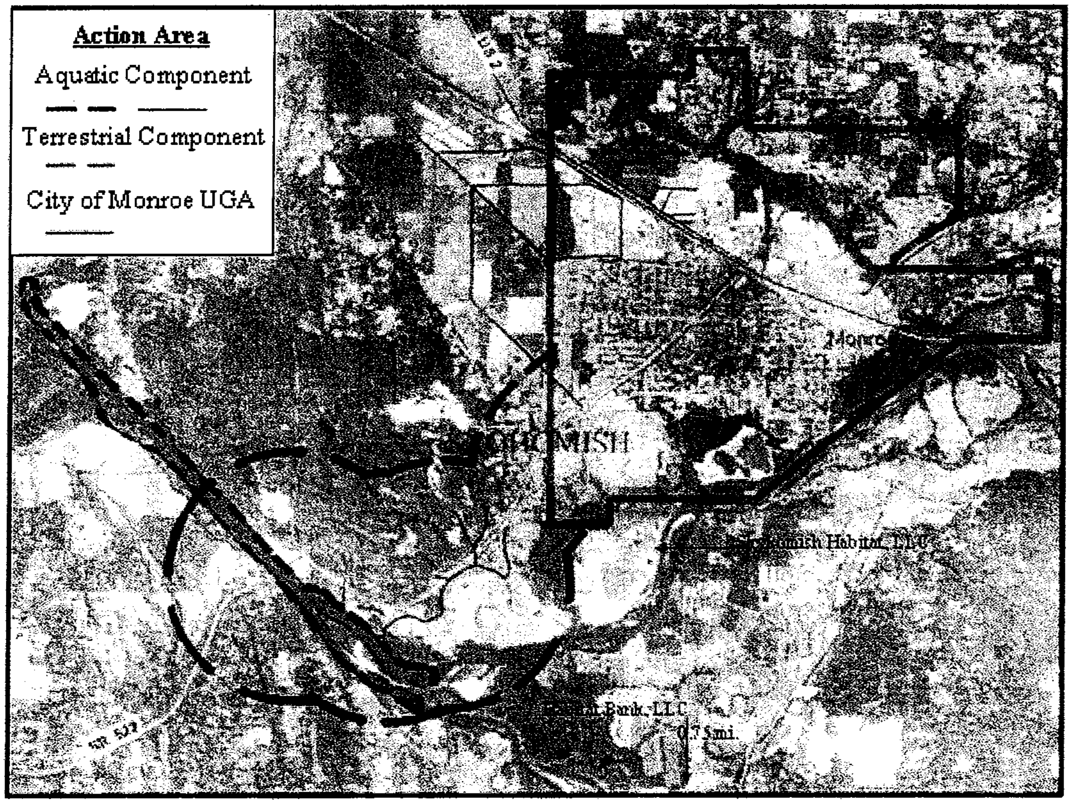
SR 522 extends approximately 25 miles in a northeasterly direction, from Interstate 405 between Bothell and Woodinville to US 2 in Monroe. SR 522 serves suburban developments in the NE Seattle metro area and unincorporated Snohomish County. The proposed project would construct safety and mobility improvements along approximately four miles of SR 522, from milepost vicinity 20.4 approximately 1,000 ft west of the Snohomish River crossing, east and north to milepost vicinity 24.7 at the SR 522 / US 2 interchange in Monroe.

Western portions of the project corridor are located along a series of roadway cuts and fills constructed at the northern edge of the Skykomish River floodplain terrace and at the toe of steep hillsides and bluffs to the immediate north ("Bald Hill"). Eastern portions of the project corridor are further removed from the floodplain and are located within the incorporated city limits of Monroe.

The existing crossing of the Snohomish River within the project limits spans approximately 500 ft of channel and 800 ft of right bank floodplain (WSDOT 2003). SR 522 crosses the Snohomish River at approximate river mile 20.5, immediately downstream of the confluence of the Skykomish and Snoqualmie Rivers. Upstream of the existing bridge the Snohomish/Skykomish floodplain is confined to the west by steep slopes, but extends broadly to the east across the wide, flat, floodplain lowlands of the lower Skykomish River. Downstream of the existing bridge the floodplain is narrower, confined to both the west and east by slopes located within 0.5 mile of the Snohomish River (WSDOT 2003).

The project is located in Water Resources Inventory Area (WRIA) 7 – Snohomish, within hydraulic unit codes (HUCs) 17110009 (Skykomish) and 17110010 (Snoqualmie). Western portions of the project corridor drain to the Snohomish River and to two unnamed, minor tributaries to the Skykomish River, one of which extends north and east through natural and "converted" portions of the floodplain south of SR 522. Eastern portions of the project corridor drain to two unnamed, minor tributaries (tributaries to Cripple Creek) within the French Creek basin. French Creek is a moderate-sized tributary to the Snohomish River and enters the Snohomish River at approximate river mile 14.3 (Carroll and Thornburg 1997).

Figure 6. Aerial photo depicting extent of the action area.



The terrestrial boundaries of the action area were defined based on the temporary increases in sound and visual disturbance that will result from construction of the project. The terrestrial boundaries of the action area also encompass those areas where land use changes may result, in whole or in part, from the proposed project. Along eastern portions of the project corridor, the City of Monroe's current Urban Growth Area (UGA) boundary has been used to define the spatial extent of the action area.

Temporary increases in sound associated with impact pile driving and controlled blasting are expected to have the farthest reaching effects in the terrestrial environment during the period of construction. The terrestrial boundaries of the action area extend a distance of at least 4,000 feet in all directions from where work activities will be conducted. Temporary increases in sound associated with construction are expected to attenuate to background levels at a distance of approximately 4,000 ft from construction activities (FHWA 2006).

The aquatic boundaries of the action area were defined based on where, and how far, suspended sediments are expected to extend upstream and downstream of work activities during construction. The aquatic boundaries of the action area were also defined based on where, and how far, elevated underwater sound pressure levels are likely to temporarily extend as a result of piling installation operations. Finally, the aquatic boundaries of the action area also encompass where potential indirect effects may result from construction of the project. The project's potential indirect effects to the aquatic environment include both those associated with operation of the proposed stormwater design and those associated with land use changes that may result, in whole or in part, from the proposed project. Along eastern portions of the project corridor, the City of Monroe's current UGA boundary has been used to define the spatial extent of the action area.

Temporarily elevated underwater sound pressure levels resulting from piling installation operations are expected to have the farthest reaching effects in the aquatic environment. The Service used the practical spreading model described by Davidson (2004) to examine underwater sound pressure generation and attenuation, and expects that temporarily elevated underwater sound pressure levels will attenuate to ambient/background levels at a distance of more than three miles upstream and downstream of piling installation operations conducted within the wetted perimeter of the Snohomish River. For a fuller discussion of these potential effects, see a section that follows (Exposure to Elevated Underwater Sound Pressure Levels).

The proposed project is one of the last phases (or the last phase) among a series of projects designed to improve SR 522, a major arterial highway, by expanding capacity along existing facilities. The project will widen approximately four miles of SR 522 from two lanes to four lanes and will improve two interchanges. The project will be designed and built to accommodate a projected increase in travel demand, from a "current" ADT of 18,000-19,000 vehicles per day (2001-2003) to an estimated ADT of 53,000 vehicles per day in the design year (2030).

It is difficult to describe with certainty where land use changes may result, in whole or in part, from the proposed project. The WSDOT has provided guidance to BA authors for assessing potential indirect effects related to changes in land use (WSDOT 2007b). Applying this guidance, BA authors describing projects that will create new facilities or that will expand the capacity of existing facilities are led through a process for evaluating potential indirect effects. However, the submitted BA does not assess changes in the rate or pattern of land use conversion, development of vacant or under-developed parcels, or conversion of agricultural or rural residential land to more intensive land uses. When defining the spatial extent of the action area, the BA relies instead only on construction-related increases in sound and visual disturbance, and temporary effects to water quality. In order to determine the full extent of the action area, the Service considered existing patterns of land use and zoning, long-term community planning and economic development objectives, and concurrency and other growth management policies and requirements. For a fuller discussion see a section that follows (Indirect Effects, Land Use Changes and Related Effects to the Environment).

Along much of the project corridor, from the Snohomish River crossing east to the vicinity of the 164th Street SE/Tester Road surface arterial interchange, SR 522 is a limited-access controlled facility. Along this portion of the corridor land use and zoning are as follows (FHWA 2006; Snohomish County 2007a): rural residential, rural conservation/open space, agricultural, commercial, parks, and mineral conservation; agricultural 10-acre, rural 5-acre, city (City of Monroe, Washington), rural conservation, forestry, and parks. The proposed action is not expected to result in land use conversion or development of vacant or under-developed parcels along and adjacent to the western portion of the corridor. For a fuller discussion of the proposed action's potential indirect effects, see a section that follows (Indirect Effects, Land Use Changes and Related Effects to the Environment).

Eastern portions of the corridor, from the 164th Street SE/Tester Road surface arterial interchange to the reconstructed SR 522 / US 2 interchange, are located entirely within incorporated city limits (City of Monroe). Here, the proposed project is important to long-term planning objectives and can be expected to facilitate growth within the City of Monroe and its UGA (FHWA 2006; Snohomish County 2007b). The Service expects the proposed action may promote and encourage land use conversion and redevelopment along this portion of the corridor. For a fuller discussion of these potential indirect effects, see a section that follows (Indirect Effects, Land Use Changes and Related Effects to the Environment).

Plans for on-site and off-site compensatory mitigation are at a preliminary stage of development and it is not possible at this time to identify with certainty where these actions will occur. Most of the project's unavoidable impacts to wetland/buffer, floodplain, and riparian functions will be mitigated off-site. The WSDOT has identified two privately owned and developed mitigation banks, located within basin, where the project may purchase credits. Actions taken at these banks have been the subject of earlier informal consultations with the Service (Skykomish Habitat, LLC – FWS Ref. No. 1-3-05-I-0426 / Cross Ref. 1-3-05-IC-0427; Habitat Bank, LLC – FWS Ref. No. 1-3-05-I-0276).

Environmental Baseline in the Action Area

Western portions of the action area and project corridor, from the Snohomish River crossing east to the vicinity of the 164th Street SE/Tester Road surface arterial interchange, are rural in character. Prominent landscape features within this portion of the action area include Lord Hill Regional Park, an approximately 1,300 acre upland nature preserve, and the lower Skykomish River floodplain. Large, relatively undisturbed stands of second-growth mixed coniferous-deciduous forest extend north from SR 522 up the flanks of "Bald Hill". The wide, flat, floodplain lowlands of the lower Skykomish River, including extensive floodplain wetlands and riparian stands, lie to the south of SR 522 and extend from the confluence of the Skykomish and Snoqualmie Rivers more than two miles north and east toward Monroe. These landscape features are interspersed with low-density rural residential housing, "hobby farms", pasture, and fields under agricultural production, much of which is located within the lower Skykomish River floodplain.

Eastern portions of the action area and project corridor, from the 164th Street SE/Tester Road surface arterial interchange to the SR 522 / US 2 interchange, are located entirely within the City of Monroe. The City of Monroe, with a current population of approximately 17,000 persons, experienced dramatic rates of growth during the 1990's (approximately 9 percent annually). These rates slowed during the early 2000's, to approximately 3 percent annually. The City's current Comprehensive Plan anticipates the population will increase to more than 26,000 persons by 2025 (City of Monroe 2005). The City of Monroe is within commuting distance of both the City of Everett and the NE Seattle metro area.

By land area, the City of Monroe contains a mix of residential (35 percent), commercial (12 percent), and declining industrial (8 percent) land uses. The City's greatest concentration of commercial and industrial developments is along US Highway 2, east and west of the SR 522 / US 2 interchange (City of Monroe 2005). Parks and open space, and "Limited Open Space" (one dwelling unit per 5 acre), account for 26 percent of the land area. The City has designated critical areas accounting for more than 25 percent of the land area (City of Monroe 2005).

The action area encompasses a mosaic of upland, riparian, and wetland habitats, including mixed coniferous-deciduous forest, expansive floodplains, isolated wetlands and more or less contiguous complexes of wetlands, and moderately- to intensively-developed urban landscapes. Topography along the project corridor may be characterized as gently rolling, with elevations ranging from approximately 20 ft above to 140 ft above mean sea level (FHWA 2006). Portions of the action area to the north of SR 522 (i.e., on "Bald Hill") achieve an elevation of 600 or more ft above mean sea level. Much or all of the landscape dominated by herbaceous or scrub-shrub vegetation shows clear signs of earlier disturbance. Low density rural residential development and agricultural land uses prevail throughout large portions of the action area to the west of the City of Monroe.

Most of the project corridor lies within HUC 17110009 (Skykomish), with only a very small portion located within HUC 17110010 (Snoqualmie). Major waterbodies within the action area include the Snohomish River, Snoqualmie River, and Skykomish River. The action area encompasses a large side-channel to the Skykomish River located immediately upstream of Bridge 522/138 (near the confluence of the Skykomish, Snoqualmie, and Snohomish Rivers), and the wide, flat, floodplain lowlands of the lower Skykomish River extending north and east toward Monroe. Also present within the action area are two unnamed, minor tributaries to the Skykomish River that drain to the above-mentioned side-channel, and two unnamed, minor tributaries to Cripple Creek within the French Creek basin. The French Creek basin drains and discharges to the Snohomish River at river mile 14.3, approximately 6 miles downstream of the project.

The Snohomish River watershed is the second largest river basin draining to the Puget Sound. Across the watershed elevations range from sea level to approximately 8,000 ft above mean sea level. The watershed's three major rivers (the Snohomish, Snoqualmie, and Skykomish Rivers) flow through glaciated valleys for a distance of approximately 80 miles in a westerly and northwesterly direction before discharging to Possession Sound (Puget Sound) in Everett, Washington (Haring 2002). The Snohomish River watershed includes approximately 25 miles of marine shoreline.

Private and Federal forests and federal wilderness areas account for approximately 73 percent of the watershed area throughout the Snohomish River basin. In 2000, rural residential and urban developments accounted for approximately 17 percent and 4 percent of the watershed area respectively (Pentec 1999). Given the rate of growth, it is probable these percentages are somewhat higher today. Agricultural and commercial/industrial land uses account for approximately 5 percent and 1 percent of the watershed area respectively (Pentec 1999).

Mean annual precipitation across the Snohomish River basin is approximately 87 inches per year (Pentec 1999). Discharge is strongly influenced by spring and early-summer snowmelt. In most years the annual hydrograph peaks between the months of November and January as a result of winter rainfall, and again in May or June in response to high elevation snowmelt. Seasonal low flows typically occur during August at gauges throughout the basin (Pentec 1999). Historical records indicate 60-70 percent of the annual peak flows occur between November and January (SAIC 2002 *in* WSDOT 2003).

The U.S. Geological Survey maintains a real-time surface water gage station located on the left bank of the Snohomish River approximately 150 ft upstream of Bridge 522/138 (USGS 2007). The gage is approximately 0.1 mile downstream of the confluence of the Skykomish and Snoqualmie Rivers and 3.6 miles south and west of the City of Monroe. At this location the Snohomish River has a drainage basin area of approximately 1,500 square miles and a mean annual discharge of approximately 9,500 cubic feet per second (cfs). Historical records from this location identify a peak measured discharge of approximately 150,000 cfs, dating from November 1990. Extremes of discharge documented between November 2006 and January 2007 range from 48,000 to 70,000 cfs (USGS 2007).

A portion of the Snohomish River downstream of Bridge 522/138 was formerly identified by the WDOE as an impaired waterbody for exceedances of metals criteria (WDOE 1999). The 1998 303(d) list identified the Snohomish River, extending from the vicinity of Shadow Lake (i.e., approximately 3 miles downstream of Bridge 522/138) downstream to the confluence with French Creek, as a Category 5 "polluted" waterbody exceeding criteria for both copper and mercury. The WDOE conducted additional sampling between 2000 and 2002 and has since concluded this segment of the Snohomish River in fact meets criteria for arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc (WDOE 2005a).

A portion of the Snoqualmie River, extending from the vicinity of Bridge 522/138 to a point approximately 1 river mile upstream, is identified as a Category 4(a) "polluted" waterbody with an approved total maximum daily load (TMDL) water clean-up plan for fecal coliform. This portion of the Snohomish River basin includes additional Category 4(a) and Category 5 waterbodies listed for exceedances of the fecal coliform criteria, including the mainstem Snohomish River in the vicinity of Shadow Lake, Woods Creek upstream of Monroe, and portions of the middle French Creek basin (WDOE 2005b). In addition, a portion of the mainstem Skykomish River upstream of Monroe, and the lower French Creek basin are identified as Category 5 "polluted" waterbodies exceeding the temperature criteria. Finally, middle and lower portions of the French Creek basin are also listed for failure to meet the dissolved oxygen criteria (WDOE 2005b).

The WSDOT has delineated more than 40 Category I, II and III palustrine emergent, scrub-shrub, and forested wetlands, totaling more than 20 acres along the project corridor (FHWA 2006). Most of these wetlands are directly adjacent to the existing road prism and provide low to moderately-low hydrologic and biologic functions. However, many of the wetlands located further to the south are located within the Skykomish River floodplain and/or have some connection to the minor tributaries extending from the Skykomish River side-channel north and east toward Monroe. These wetlands support a variety of woody and herbaceous species; some are dominated by non-native/invasive species, while others have a significant and relatively undisturbed native component. Where there are more or less contiguous complexes of wetlands and waterbodies, these landscape features contribute to the connectivity of terrestrial wildlife habitats.

The lower Skykomish River floodplain extending east from the vicinity of Bridge 522/138 and the confluence of the Skykomish and Snoqualmie Rivers is an active channel migration zone. The Skykomish River has a comparatively steeper average streambed gradient than either the Snoqualmie or the Snohomish Rivers, transports a significant annual bed load, and deposits large quantities of sediment each year along the low flood plain expanse between the City of Monroe and the confluence of the Skykomish and Snoqualmie Rivers (Pentec 1999). This portion of the Skykomish is dynamic and experiences frequent channel shifts. Flood events, including large events documented during 1977 and 1990, have been the cause for avulsions and dramatic shifts in alignment that have occurred with some frequency (WSDOT 2003).

The large side-channel to the Skykomish River within the action area once carried most of the river's flow through the confluence area and discharged to the Snohomish River at a point in close proximity to Bridge 522/138. Since 1990, when flood events caused an avulsion and lead to an upstream displacement of the confluence by more than 2,000 ft, portions of the side-channel to the Skykomish River have aggraded and filled to a point where they are nearly or entirely dry during low flows (WSDOT 2003). However, the side-channel still carries a portion of the river's flow through the confluence area. Flows with a recurrence interval of one year or greater are sufficient to cause the side-channel to top its bank and spill over into the floodplain terrace immediately upstream and below Bridge 522/138. The WSDOT has documented inundation of the floodplain immediately below the bridge in response to a 1- to 2-year flood event and estimates that a 100-year flood event could increase depths immediately below the bridge to more than 10 ft (WSDOT 2003). During 2004 the WSDOT constructed a series of three rock and wood barbs and related bank stabilization measures intended to stabilize and mitigate the risk of scour and avulsion along the portion of the Skykomish River side-channel closest to Bridge 522/138 (USFWS 2004a).

The major rivers within the action area support more than 12 distinct stocks of chum (*Oncorhynchus keta*), coho (*O. kisutch*), Chinook (*O. tshawytscha*), pink (*O. gorbuscha*), and steelhead (*O. mykiss*) salmon. While the Skykomish and Snoqualmie populations of Chinook salmon and Snohomish/Skykomish and Snoqualmie populations of winter steelhead salmon are considered "depressed", eight populations of chum, coho, and pink salmon are considered "healthy" (WDFW 2002). The "spawner distribution" for five stocks (Skykomish Chinook, Snoqualmie coho, Snohomish odd-year and even-year pink, and Snohomish/Skykomish winter steelhead) include portions of the Snohomish, Snoqualmie, and Skykomish Rivers within the action area (WDFW 2002).

Factors that limit salmonid productivity in the Snohomish River watershed include but are not limited to the following: fish access (blockages), floodplain modifications, channel and substrate conditions, riparian conditions, water quantity and quality, lake conditions (e.g., shoreline hardening, summer flows, etc.), and invasive species. These limiting factors are further detailed in Haring (Haring 2002).

The current baseline in-stream habitat and watershed conditions may be assessed applying the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998). The matrix provides a framework for considering the effects of individual or grouped actions on habitat elements and processes important to the complete life cycle of bull trout. The matrix is a useful tool for describing whether habitat is functioning adequately, functioning at risk, or functioning at unacceptable levels of risk.

What follows is a summary applying the matrix at the scale of the action area. Where appropriate these sub-sections differentiate between the conditions that prevail along the major rivers, the minor tributaries to the Skykomish River and Cripple Creek, and the larger "watershed" as a whole.

Temperature

The waters within the action area are *functioning at risk* for the temperature indicator. Data collected at monitoring stations on the Skykomish and Snoqualmie Rivers indicate that daily maximum temperatures in excess of 15 °C are commonplace during summer months (DOE 2007). Temperatures conducive to spawning (4 to 9 °C) are not uncommon during winter months, but the temperatures necessary for egg incubation (2 to 5 °C) are rare at all times of year. Short duration extremes of temperature, in excess of 20 °C, have been documented in the action area and further upstream (WDOE 2007).

While there are few or no monitoring data to confirm this, it is reasonable to assume that some of the minor tributaries within the action area experience extremes of temperature during summer months. The two unnamed, minor tributaries to Cripple Creek within the action area are substantially degraded and exhibit a channelized condition with little or no functioning riparian vegetation. The lower French Creek basin, several river miles downstream of the action area, is identified on the Washington State 303(d) list of impaired waterbodies for exceedances of the temperature criteria (WDOE 2005b).

By contrast, the two minor tributaries which extend from the Skykomish River side-channel north and east toward Monroe are fed in part by springs originating on the flanks of Bald Hill and have relatively undisturbed riparian corridors upslope of SR 522. While these minor tributaries to the Skykomish River may exhibit moderated summer surface water temperatures, there is also information to suggest flows are much reduced and portions of these channels go entirely dry during the summer months (FHWA 2006).

Sediment

The waters within the action area are *functioning at risk* for the sediment indicator. The substrates of the mainstem Snohomish River and Skykomish River overflow side-channel are dominated by coarse sand intermixed with large cobble (mean diameter of approximately 12 inches)(FHWA 2006). Data collected at monitoring stations on the Skykomish and Snoqualmie Rivers indicate total suspended solids (TSS) concentrations are typically very low during low flow summer months and, on average, not too greatly increased during winter months. Mean "winter" (October 1 – April 30) TSS, derived from more than 25 years of monitoring data

(WDOE 2007), is approximately 11 mg/L and 19 mg/L at the Skykomish and Snoqualmie monitoring stations respectively. Events resulting in TSS measures in excess of 20 mg/L (50 mg/L at the Snoqualmie monitoring station) are uncommon.

Throughout the portions of the two unnamed, minor tributaries to the Skykomish River and two unnamed, minor tributaries to Cripple Creek within the action area substrates are dominated by silt, clay, mud, and organic material (FHWA 2006). Small, discontinuous patches of gravel and small cobble are infrequent.

Chemical Contamination / Nutrients

The waters within the action area are *functioning at risk* for the contamination indicator. A portion of the Snoqualmie River, extending from the vicinity of Bridge 522/138 to a point approximately 1 river mile upstream, has an approved TMDL clean-up plan for fecal coliform. No other portions of the action area have been listed for routine violation of the State's surface water quality standards. However, middle and lower portions of the French Creek basin, downstream of the action area, are identified on the Washington State 303(d) list of impaired waterbodies for failure to meet dissolved oxygen and fecal coliform standards (WDOE 2005b).

Access Barriers

The waters within the action area are *functioning at unacceptable risk* for the access indicator. There are no natural or man-made barriers to fish passage along portions of the major rivers within the action area. However, there are both natural and man-made barriers to fish passage along the two unnamed, minor tributaries to the Skykomish River, and the two unnamed, minor tributaries to Cripple Creek within the action area.

Western portions of the project corridor drain to the Snohomish River and to two unnamed, minor tributaries to the Skykomish River. Both of the minor tributaries drain and discharge to the Skykomish River side-channel located on the right bank immediately upstream of Bridge 522/138.

One of these minor tributaries [identified in the BA as "07-0814(e)"] extends approximately 2,000 linear feet upstream, both as a defined channel and as dispersed flow associated with floodplain wetlands, before passing through closed conveyances below both Tester Road and SR 522. After passing below SR 522 this tributary extends as a defined channel for approximately 140 ft; the hillside seeps contributing flow to this tributary form a defined channel only 80 ft upslope of SR 522. The 18-inch diameter cross culverts conveying this minor tributary below SR 522 and Tester Road are a barrier to fish movement. However, with little or no fish habitat located upstream of the crossings, the proposed project will simply extend these structures and does not propose to improve them for fish passage.

The second of the two minor tributaries to the Skykomish River [identified in the BA as "07-0814(a)-(d)" and "07-0012(a)/(b)"] extends for a considerably greater distance north and east through natural and "converted" portions of the floodplain south of SR 522. One branch of this tributary ["07-0814(a)/(b)"] extends for an additional 3 miles upstream of SR 522 along the flank of Bald Hill. The various braches of this second minor tributary to the Skykomish River cross below Tester Road and SR 522 at five locations. At four of the five locations there is little or no fish habitat located upstream of the crossings, and the proposed project will simply extend these structures rather than improve them for fish passage. The branch identified as "07-0814(a)/(b)" is currently conveyed below SR 522 through twin 24-inch diameter corrugated metal cross culverts which have been identified as partial fish passage barriers (WDFW 2007a; WDFW/WSDOT 2007). The proposed project will improve these crossings by replacing the existing cross culverts with an approximately 8-foot high, by 28-foot wide, by 180-foot long bottomless structure and with an approximately 96-inch diameter by 165-foot long countersunk corrugated metal cross culvert. Both of the proposed replacement structures will be designed and built to meet all relevant and applicable WAC criteria for fish passage.

Eastern portions of the project corridor drain to two unnamed, minor tributaries to Cripple Creek. These tributaries [identified in the BA as "07-0186(a)/(b)" and "07-0186(c)-(e)"] cross the project corridor within the SR 522 / US 2 interchange and the 164th Street SE/Tester Road surface arterial interchange respectively. At both locations these minor tributaries exhibit a heavily degraded baseline condition and there is little or no functional fish habitat either within the existing interchange areas or further "upstream". Downstream portions of these tributaries, including all portions within the action area, exhibit a similarly degraded baseline condition. These minor tributaries to Cripple Creek are ditched and channelized with little or no functioning riparian vegetation, and fragmented by a network of closed and open conveyances to a distance of more than 3.5 miles downstream. As part of the planned improvements to the SR 522 / US 2 interchange and 164th Street SE/Tester Road surface arterial interchange the project proposes to extend existing culverts and drainage structures, and does not propose to improve them for fish passage.

Substrate Embeddedness

The waters within the action area are *functioning at risk* for the substrate embeddedness indicator. See content included above for the sediment indicator.

Large Woody Debris

The waters within the action area are *functioning at unacceptable risk* for the LWD indicator. Systematic removal of LWD to improve navigation and mitigate flood hazard, removal of adjacent riparian vegetation, and decoupling of the active channel and floodplain have all contributed to reduced amounts of LWD and reduced potential for recruitment of LWD along the major rivers within the action area. Along the minor tributaries within the action area amounts of LWD and potential for recruitment of LWD vary. However, LWD is entirely absent from portions of the minor tributaries within the action area and, in general, both sources of LWD and conveyance of LWD are much reduced compared to historic conditions.

Pool Frequency and Quality; Large Pools

The waters within the action area are *functioning at risk* for these indicators. The major rivers within the action area provide large, deep pools across a range of flows and with adequate frequency. However, many of these pools are riprap-augmented freeform pools with reduced LWD, cover, and channel complexity (FHWA 2006).

Along the minor tributaries within the action area pool frequency and quality vary. Along the tributaries to Cripple Creek, pool frequency and quality are both greatly reduced as a result of channelization and the absence of LWD. Along the minor tributaries to the Skykomish River, conditions are not conducive to formation and maintenance of stable pools (i.e., substrates are fine and sources of LWD are reduced) and yet these tributaries do connect to a series of remnant oxbows, beaver ponds, and inundated wetlands. Deep pools offering cold water and complex cover are few in number.

Off-Channel Habitat; Refugia

The waters within the action area are *functioning at risk* for these indicators. Along the major rivers within the action area the availability and quality of off-channel habitats and refugia are reduced compared to historic conditions. Sources of LWD are inadequate and this, combined with bank armoring, reduces the availability of complex cover. However, these large rivers do provide deep pools, thermal refugia, point bars, side-channels, and other forms of channel complexity across a range of flows.

Along the minor tributaries within the action area the availability and quality of off-channel habitats and refugia vary. The tributaries to Cripple Creek have been channelized and little or no channel complexity remains; these habitats are functioning at unacceptable levels of risk for these indicators. The tributaries to the Skykomish River connect to a series of diverse habitats, including remnant oxbows, beaver ponds, and inundated wetlands. Along these tributaries both complex cover and the availability of thermal refugia are reduced compared to historic conditions; these habitats are functioning at risk for these indicators.

Width:Depth Ratio

The waters within the action area are *functioning at risk* for this indicator. Both the major rivers and the minor tributaries within the action area are characterized by width:depth ratios in excess of 10. Portions of the minor tributaries within the action area are seasonally intermittent and/or experience seasonal periods of very low flow. Portions of the Skykomish River side-channel go nearly or entirely dry during low flows (FHWA 2006).

Streambank Condition

The waters within the action area are *functioning at risk* for this indicator. Portions of the major rivers within the action area are stabilized with bank armoring and/or constructed dikes. Some of the minor tributaries within the action area have been channelized. Along the minor tributaries within the action area bank instability is not pervasive, but some reaches are without adequate riparian vegetation to enhance stability and substrates are erodible.

Floodplain Connectivity

The waters within the action area are *functioning at risk* for this indicator. Portions of the major rivers within the action area are stabilized with bank armoring and/or constructed dikes, effectively decoupling or reducing interactions between the active channel and adjacent floodplain. Along the minor tributaries to the Skykomish River within the action area, lower portions connect to a series of remnant oxbows and inundated wetlands within the floodplain. However, the existing road prism associated with SR 522 and Tester Road dramatically alters conditions at the periphery of the Skykomish River floodplain and reduces interactions between the floodplain and upper portions of these tributaries. The minor tributaries to Cripple Creek within the action area have been ditched, channelized, and are conveyed by enclosed drainage structures at some locations; these tributaries are functioning at unacceptable levels of risk for this indicator.

Change in Peak / Base Flows

The waters within the action area are *functioning at risk* for this indicator. The extent to which the natural hydrograph has been altered as a result of current and historical land use practices in the upper and middle watershed is not easily quantified. Gersib *et. al.* (Gersib *et. al.* 1999 *in* Haring 2002) evaluated baseflows over the period 1963-1997 at three stations in the Snohomish basin and found an apparent decline, including an approximately 15-20 percent decline in mean baseflow at the mainstem Snohomish gauge. However, the data show considerable scatter and Gersib *et. al.* state that conclusions should be drawn with caution. It does not appear that within the action area flood event cycles or peak flows have been substantially altered compared to historical conditions.

The two minor tributaries connecting to the Skykomish River side-channel are fed in part by springs originating on the flanks of Bald Hill. Information suggests that flows are much reduced and portions of these channels go entirely dry during the summer months (FHWA 2006).

Drainage Network

The waters within the action area are *functioning at risk* for this indicator. Within the action area there has been a moderate increase in drainage network density due to the presence of roads.

Road Density & Location

The waters within the action area are *functioning at unacceptable risk* for this indicator. SR 522 and Tester Road are both "valley bottom roads" throughout western portions of the project corridor and action area. The existing crossing of the Snohomish River within the project limits (Bridge 522/138) is positioned across a dynamic confluence area. Bridge 522/138 features a single pier placed mid-channel and six additional piers placed along the banks and within the Snohomish/Skykomish floodplain (WSDOT 2003). Eastern portions of the project corridor are intensively developed and the minor tributaries throughout these portions of the action area have been ditched and channelized to accommodate both developed land uses and an extensive surface street network.

Disturbance Regime & History

The waters within the action area are *functioning at risk* for this indicator. Both historical and current land use practices in the upper and middle watershed continue to have lasting impacts on floodplain and riparian functions, instream habitat diversity and the availability of off-channel habitats and refugia.

Riparian Reserves

The waters within the action area are *functioning at risk* for this indicator. Along the major rivers within the action area riparian reserves are reduced, LWD inputs are lacking, and riparian stands are both less mature, and contain a more significant deciduous component compared to historical conditions.

Along the minor tributaries within the action area riparian conditions vary. The minor tributaries to Cripple Creek are ditched and channelized with little or no functioning riparian vegetation; these tributaries are functioning at unacceptable levels of risk for this indicator. Along the minor tributaries to the Skykomish River, riparian reserves are reduced and less mature compared to historical conditions but retain important functions.

Status of the Species in the Action Area

The Service considers the waters within the action area to be FMO habitat for bull trout. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas (USFWS 2004b). Many bull trout of the Snohomish-Skykomish core area are anadromous and therefore rely on middle portions of the Snohomish basin for migrating, overwintering, extended rearing, and growth to maturity (USFWS 2004b). The major rivers within the action area provide important FMO habitat for anadromous bull trout of the Snohomish-Skykomish core area. Adult, subadult, and juvenile bull trout may occupy these waters at any time of year, but information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

The Snohomish-Skykomish core area (Puget Sound Management Unit) includes the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout are distributed throughout these waters, generally downstream of anadromous barriers (USFWS 2004b). Fluvial, resident, and anadromous life histories are all found within the core area. The Snohomish-Skykomish core area plays a critical role in the conservation and recovery of bull trout, since each core area is vital to maintaining the overall distribution and genetic diversity of bull trout within the Unit (USFWS 2004b).

The Snohomish-Skykomish core area supports four known, identified local populations (North Fork and South Fork Skykomish, Salmon Creek, and Troublesome Creek). Troublesome Creek, a tributary to the North Fork Skykomish River, supports a largely resident population (USFWS 2004b). With only four local populations, bull trout in this core area are considered at increased risk of extirpation and adverse effects from random, naturally occurring events. The lack of connectivity with the Troublesome Creek local population is a natural condition. Connectivity between the other three local populations diminishes the risk of extirpation in the core area from habitat isolation and fragmentation.

Current information suggests the core area's spawning and early rearing habitats are found only within the Skykomish River basin, generally at elevations ranging from 1,000 to 1,500 ft above mean sea level (USFWS 2004b). The amount of spawning and early rearing habitat is more limited, in comparison with many other core areas, because of the topography of the basin. Upper portions of the North Fork Skykomish River, including Salmon Creek and Troublesome Creek, appear to be major areas of production. Rearing bull trout can be found throughout the anadromous portions of the Snohomish, Skykomish, North Fork and South Fork Skykomish Rivers (USFWS 2004b).

The waters within the action area are FMO habitat for bull trout. Migratory bull trout use nonnatal watersheds (habitat located outside of their spawning and early rearing habitat) to forage, migrate, and overwinter (Brenkman and Corbett 2003a,b *in* USFWS 2004b). Current information suggests many bull trout of the Snohomish-Skykomish core area are anadromous and therefore rely on middle portions of the Snohomish basin (including tributaries to the mainstem Snohomish River), the lower estuary, and nearshore marine areas for migrating, overwintering, extended rearing, and growth to maturity (USFWS 2004b).

Juvenile, subadult, and adult bull trout may be found throughout the mainstem Snohomish and Skykomish Rivers. Fluvial subadult and adult bull trout are believed to typically forage and overwinter in large pools along middle portions of the mainstem Skykomish River (USFWS 2004b). The mainstem Snohomish River provides important overwintering habitat for anadromous bull trout, including subadult bull trout from populations outside of the Snohomish-Skykomish core area (USFWS 2004b).

Habitat conditions in the North Fork Skykomish basin, including water quality, are generally good to excellent (WDFW 2004). There has been some loss of side-channel habitat due to diking and construction of bank protection measures. Habitats throughout parts of the South Fork Skykomish basin have been substantially degraded by logging and road construction, especially in the Beckler and Tye watersheds (WDFW 2004). Where habitats along the mainstem Snohomish and Skykomish Rivers have been degraded as a result of diking, maintenance of inadequate riparian buffers, or other land use practices (e.g., draining of floodplain wetlands for agricultural purposes) this has reduced the amount of FMO habitat historically available to bull trout. Limiting factors have been discussed in great detail elsewhere (Haring 2002).

Threats and reasons for decline in the Snohomish-Skykomish core area include the following (USFWS 2004b):

- Past timber harvest and harvest-related activities have degraded habitat conditions in the upper watershed.

- Agricultural and livestock practices have altered stream morphology and floodplain habitat, and degraded water quality in the middle and lower watershed.
- Municipal and industrial effluent discharges and development contribute to degraded surface water quality.
- Nearshore foraging habitat has been, and continues to be, affected by development activities.
- Illegal harvest or incidental hooking mortality may occur at several campgrounds where recreational fishing is allowed.
- Hybridization with introduced brook trout is considered a potential threat to the persistence of bull trout. Brook trout have been introduced into many lakes throughout the Skykomish subbasin and are known to occur in the South Fork Skykomish River above Sunset Falls.

Current information regarding adult abundance and productivity suggests bull trout of the Snohomish-Skykomish core area have relatively stable but low numbers (J. Chan pers. comm. 2007). Trap-and-haul facilities continue to pass returning adults into the South Fork Skykomish River above Sunset Falls, where it appears new spawning and rearing areas are being colonized (USFWS 2004b). Since 1988, redd counts conducted annually along the North Fork Skykomish River have documented a trend toward increasing numbers, with a peak of approximately 530 redds documented in 2002 (USFWS 2004b). Counts along the North Fork Skykomish River declined to approximately 240 redds in 2005 and 2006 (WDFW 2007b). The decline may be attributable to low flows, followed by scouring flows, during and following those spawning seasons (J. Chan pers. comm. 2007). The WDFW considers the Snohomish-Skykomish bull trout population "healthy" (WDFW 2004).

The State of Washington allows a two-fish daily bag limit (20-inch minimum size limit) for native char (bull trout and Dolly Varden) caught by anglers in either the mainstem Snohomish River or the Skykomish River below the forks. All other areas in the basin are closed to fishing for native char (WDFW 2004). Poaching of adult native char has been identified as an ongoing problem in the upper North Fork Skykomish River.

The major rivers within the action area, including the side-channel located upstream of Bridge 522/138, are known to support bull trout. Bull trout have been documented at the north end of the Skykomish River side-channel within 1,500 ft of where the proposed project would conduct in-water construction activities (C. Kraemer pers. comm. 2003). While there is some information to suggest bull trout may avoid seasonally high surface water temperatures within the mainstem Snohomish River by seeking out cooler waters in the Skykomish River, telemetry studies have documented bull trout along the mainstem Snohomish River late into the month of July (F. Goetz pers. comm. 2002). The major rivers within the action area provide large, deep pools across a range of flows and the Service expects juvenile, subadult, and adult bull trout may occupy these waters at any time of year.

The major rivers within the action area provide important FMO habitat for all anadromous bull trout of the Snohomish-Skykomish core area. These portions of the mainstem Snohomish, Skykomish and Snoqualmie Rivers are critically important as migratory habitat for bull trout accessing productive foraging areas in other portions of the watershed (including lower estuary and nearshore marine areas). The dynamic confluence of the Skykomish and Snoqualmie Rivers provides microhabitat conditions where bull trout can seek refuge from seasonally high flows. The Skykomish River overflow side-channel within the action area is poorly connected to the main channel at low flow, but provides good off-channel habitat during the medium to high flows that prevail for much of the year. The major rivers within the action area provide large, deep pools where bull trout can productively forage and where bull trout can seek refuge from seasonally high surface water temperatures. Information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

The two, unnamed tributaries that extend from the Skykomish River side-channel, north and east across the floodplain toward Monroe, are expected to support low numbers of juvenile, subadult, and adult bull trout. South of SR 522, these tributaries connect a series of remnant oxbows, beaver ponds, and inundated wetlands to the Skykomish River side-channel and mainstem Snohomish River. While these areas do not contain suitable spawning habitat, they do provide a limited amount of low-quality rearing habitat. Substrates are dominated by fines with a high degree of embeddedness, deep pools are few in number, and LWD and other sources of complex cover are reduced compared to historical conditions. During the summer months surface water temperatures along the minor tributaries are almost certainly elevated compared to the major rivers within the action area. These tributaries likely function most importantly as off-channel habitat where subadult and adult bull trout may seek refuge from adverse conditions in the mainstem rivers, particularly during periods of high flow.

The two unnamed, minor tributaries to Cripple Creek are substantially degraded and are located within a subbasin which provides little or no suitable habitat for bull trout. Middle and lower portions of the French Creek basin, downstream of the action area, are identified on the Washington State 303(d) list of impaired waterbodies for failure to meet temperature and dissolved oxygen standards (WDOE 2005b). Within the action area these tributaries exhibit a channelized condition with little or no functioning riparian vegetation and poor channel and instream habitat conditions. Within and beyond the action area these tributaries flow through a network of closed and open conveyances to a distance of more than 3.5 miles downstream. These tributaries do not provide suitable habitat for bull trout and the Service does not expect these tributaries support bull trout at any time of year.

Status of Critical Habitat in the Action Area

The entire length of the Snohomish River, from its mouth at Possession Sound upstream to the confluence of the Skykomish and Snoqualmie Rivers, including Ebey Slough, Steamboat Slough, and Union Slough is designated as critical habitat for bull trout (Unit 28 – Puget Sound)(Federal Register 50 CFR 17; September 26, 2005; 56212). The Service has also designated the Snoqualmie River (from its mouth upstream to Snoqualmie Falls), the mainstem Skykomish River (from its mouth upstream to the confluence of the North and South Forks), and the South

Fork Skykomish River (upstream to the confluence of the Tye and Foss Rivers) as critical habitat. This critical habitat designation includes portions of one major tributary to the lower Snohomish River (Pilchuck Creek), one major tributary to the Snoqualmie River (Tolt River / South Fork Tolt River), and one major tributary to the South Fork Skykomish River (Foss River)(Unit 28 – Puget Sound)(Federal Register 50 CFR 17; September 26, 2005; 56212). The final rule excluded from designation portions of several major and minor tributaries included in the proposed rule, including the North Fork Skykomish River upstream to a natural barriers falls between Goblin and Quartz Creek (Federal Register 50 CFR 17; June 25, 2004; 35768).

The major rivers within the action area, including the side-channel located upstream of Bridge 522/138, contain seven of the eight primary constituent elements (PCEs) that define bull trout critical habitat (Federal Register 50 CFR 17; September 26, 2005; 56212). The minor tributaries within the action area, both the minor tributaries to the Skykomish River and the minor tributaries to Cripple Creek, are not designated as bull trout critical habitat. The baseline conditions of each PCE in the action area are described below. Each PCE was also described in a previous section ("Status of Critical Habitat").

(1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

Data collected at monitoring stations on the Skykomish and Snoqualmie Rivers indicate daily maximum temperatures in excess of 15 °C are commonplace during summer months (DOE 2007). Temperatures conducive to spawning (4 to 9 °C) are not uncommon during winter months, but the temperatures necessary for egg incubation (2 to 5 °C) are rare at all times of year. Short duration extremes of temperature, in excess of 20 °C, have been documented in the action area and further upstream (DOE 2007). However, the designated critical habitat within the action area (i.e., portions of the mainstem Snohomish, Snoqualmie, and Skykomish Rivers) provides large, deep pools where bull trout can seek refuge from seasonally high surface water temperatures at any time of year.

(2) *Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.*

The designated critical habitat within the action area (i.e., portions of the mainstem Snohomish, Snoqualmie, and Skykomish Rivers) provides deep pools, thermal refugia, point bars, side-channels, and other forms of channel complexity across a range of flows. However, some of the banks along these reaches have been stabilized with armoring and/or constructed dikes, effectively decoupling or reducing interactions between the active channel and adjacent floodplain. Sources of LWD, recruitment of LWD, and the availability and quality of off-channel habitats and refugia are all reduced compared to historical conditions. Some of the pools along these reaches are riprap-augmented freeform pools with reduced LWD, cover, and channel complexity (FHWA 2006).

(4) *A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.*

The extent to which the natural hydrograph has been altered as a result of current and historical land use practices in the upper and middle watershed is not easily quantified. Gersib *et. al.* (Gersib *et. al.* 1999 *in* Haring 2002) evaluated baseflows over the period 1963-1997 at three stations in the Snohomish basin and found an apparent decline, including an approximately 15-20 percent decline in mean baseflow at the mainstem Snohomish gauge. However, the data show considerable scatter and Gersib *et. al.* state that conclusions should be drawn with caution. It does not appear that within the action area flood event cycles or peak flows have been substantially altered or depart substantially from historical conditions. From a landscape perspective, reduced floodplain capacity and altered land use patterns (including expanding intensively-developed areas in the middle watershed) imply some level of influence on peak/base flows.

(5) *Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.*

The major rivers within the action area are fed by both glacial melt and seasonal snow melt originating at high elevations of the Cascade Range. These reaches are also fed by several small tributaries and springs originating on the flanks of Bald Hill and on the opposite (west) side of the Snohomish River floodplain. Daily maximum temperatures in excess of 15 °C are commonplace during summer months (WDOE 2007), suggesting sources of cold water are not sufficient to maintain temperatures within the optimal range during all times of year. However, telemetry studies have documented bull trout along the mainstem Snohomish River late into the month of July (F. Goetz pers. comm. 2002) and the designated critical habitat within the action area provides large, deep pools where bull trout can seek refuge from seasonally high surface water temperatures at any time of year.

(6) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

There are no physical or biological impediments to migratory corridors within the action area. There are no natural or man-made barriers to fish passage between the action area, Possession Sound, and the nearshore marine habitats of Puget Sound. However, along much of the lower Snohomish River downstream of the action area, the active channel is disconnected from off-channel habitats historically used by salmonids and along some portions (including various sloughs in the lower Snohomish River) degraded surface water quality continues to be a concern (Haring 2002). Much of the high-quality spawning and early rearing habitat in the core area is below natural barriers in the upper portions of the watershed. Fish passage between the action area and these upper elevation habitats is unobstructed.

(7) *An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

The Snohomish, Snoqualmie, and Skykomish Rivers and their tributaries support populations of chum, coho, Chinook, pink and steelhead salmon, in addition to resident and sea-run cutthroat trout; these populations provide an ample prey base for adult and subadult bull trout. However, within the action area there is little overhanging riparian vegetation and terrestrial sources of prey are probably limited along these reaches.

(8) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

In general, the major rivers within the action area have good water quality. A portion of the Snoqualmie River, from the vicinity of Bridge 522/138 approximately 1 RM upstream, has an approved TMDL clean-up plan for fecal coliform. No other portions of the action area have been listed for routine violation of the State's surface water quality standards (WDOE 2005b). Although base flows may be somewhat reduced compared to historical conditions (Gersib *et. al.* 1999 *in* Haring 2002), critical habitat within the action area provides deep pools, thermal refugia, point bars, side-channels, and other forms of channel complexity across a range of flows.

Effects of Past & Contemporaneous Actions

Current and historical land use practices in the upper, middle, and lower portions of the Snohomish basin continue to have a lasting impact on floodplain and riparian functions, instream habitat diversity, and the availability of off-channel habitats and refugia. Habitats throughout parts of the South Fork Skykomish basin have been substantially degraded by logging and road construction, especially in the Beckler and Tye watersheds (WDFW 2004). Where habitats along the mainstem Snohomish and Skykomish Rivers have been degraded as a result of diking, maintenance of inadequate riparian buffers, or other land use practices (e.g., draining of floodplain wetlands for agriculture), the amount of FMO and rearing habitat has been reduced.

Between 1999 and 2007 the Service issued ten BOs and approved at least two HCPs where incidental take of bull trout from the Snohomish-Skykomish core area was anticipated and exempted (Table 4). The authorizations granted for these actions exempt incidental take where in-water work was/is expected to result in temporary sediment increases, where instream habitat would be/will be permanently altered, and (less commonly) where fish handling related to salvage and relocation and/or in-water impact pile driving might cause direct harm to bull trout.

Table 4. Previous BOs and HCPs exempting take of Snohomish-Skykomish bull trout.

Project Name	Location
Interstate 90 Land Exchange	Outside the action area.
Stossel Creek Way - Harris Creek Culvert Replacement	Outside the action area.
Everett Bridges Seismic Retrofit	Outside the action area.
State Route 2, Snohomish River Bridge Replacement	Outside the action area.
Anthracite Creek Bridge Scour Repair	Outside the action area.
State Route 104, Hood Canal Bridge Retrofit and East Half Replacement Project	Outside the action area.
Anacortes Ferry Terminal Tie-Up Slip and Dolphin Replacement Project	Outside the action area.
State Route 522, Paradise Lake Road to Cathcart Road (Widening and Interchange Improvements), FHWA	**Within the action area.**
State Route 522, Snohomish River Bridge (522/138) Scour Repair Project, FHWA	**Within the action area.**
USFWS Programmatic for Western Washington Restoration Activities (2002-2007 & 2006 -2013)	Outside the action area.
Washington State DNR Forest Practices HCP	**Portions within the action area.**
Washington State DNR HCP for State Trust Lands	**Portions within the action area.**

The Service determined that each of these actions is not likely to jeopardize the continued existence of bull trout and will not destroy or adversely modify designated bull trout critical habitat. The combined effects of these past and contemporaneous Federal actions have resulted in short- and long-term adverse effects to bull trout of the Snohomish-Skykomish core area and incremental degradation of the environmental baseline.

Only two of the ten above-mentioned BOs addressed actions within the action area of the proposed project. The authorizations granted for two FHWA actions involving SR 522 west of the Snohomish River crossing (SR 522, Paradise Lake Road to Cathcart Road; FWS Ref.# 1-3-02-F-1161) and Bridge 522/138 (SR 522, Snohomish River Bridge Scour Repair Project; FWS Ref.# 1-3-04-F-0007) exempt incidental take of Snohomish-Skykomish bull trout. These incidental take exemptions address in-water construction activities and temporary increases in turbidity and sedimentation that are both limited in physical extent and duration (i.e., not to exceed the period of construction and immediately thereafter). These BOs also exempt incidental take related to permanent alterations of instream habitat. The previous FHWA actions at and in the vicinity of the existing Snohomish River crossing (Bridge 522/138) permanently degraded proximately 0.25 acres of FMO habitat along two-hundred or more linear feet of armored streambank (USFWS 2003, 2004b). This habitat is located on the left and right banks of the mainstem Snohomish River in the immediate vicinity of Bridge 522/138, and extends along the lowermost portion of the Skykomish River side-channel directly upstream of the bridge.

State and local actions affecting Snohomish-Skykomish bull trout and designated critical habitat within the Snohomish basin include the planning and implementation of various TMDL clean-up plans for the Snohomish River estuary, the lower mainstem Snohomish River and its tributaries, and the Snoqualmie River. Since 1992 the State of Washington, local, and private partners have been implementing an approved TMDL clean-up plan for dioxin in the lower Snohomish River. Limited monitoring results from a handful of pulp and paper mills operating with allowable dioxin discharge permits in western Washington suggest that effluent and sludge targets are generally being met and conditions in receiving waters are generally improving (Onwumere 2003).

The State of Washington is implementing a TMDL for fecal coliform bacteria and a related pollution prevention plan for dissolved oxygen in the lower Snohomish River tributaries, including French Creek and Woods Creek. The plan outlines State, local, and private actions directed at achieving loading reductions. Many of the actions relate to controlling point and non-point sources of pollution associated with agriculture (Svrjcek 2003). The State of Washington is also assessing the need for a temperature TMDL for a significant portion of the mainstem Snoqualmie River, extending from its mouth (within the action area) to a distance of more than 40 RM upstream (Kardouni and Cristea 2006). Over the long-term, implementation of these various clean-up plans may help achieve compliance with Washington's surface water quality criteria.

Managed public and private forest is the dominant land use throughout the Snohomish basin (Pentec 1999). Conditions that limit or reduce habitat productivity and function in the upper watersheds may improve over the long-term as a result of modern forest practices and implementation of the Forest Practices Act.

EFFECTS OF THE ACTION (Bull Trout and Designated Critical Habitat)

This section addresses the direct and indirect effects of the proposed action and its interrelated and interdependent activities. The regulations implementing the Act define "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline" (50 CFR section 402.02).

The proposed action is expected to result in both direct and indirect effects to bull trout and to designated bull trout critical habitat. Some of these effects will be temporary, construction-related, and limited in both extent and duration. Others are expected to be permanent, long-term and/or operational. The effects analysis that follows addresses these effects, as well as any potential effects associated with interrelated and interdependent actions.

The proposed action is expected to have measurable adverse effects to bull trout and designated bull trout critical habitat. Construction activities will directly affect instream habitat that supports bull trout and bull trout may be present at the time of construction. While work conducted below the OHWM would be completed during approved in-water work windows, bull trout may use portions of the action area at any time of year and the likelihood of exposure of adult, subadult, and juvenile bull trout to construction activities is not discountable.

Bull trout will be temporarily exposed to elevated underwater sound pressure levels resulting from impact pile driving and to temporarily elevated levels of turbidity. Impact pile driving conducted below the OHWM of the mainstem Snohomish River has the potential to kill or injure a limited number of individuals. Impact pile driving may also interfere with or disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter) to a distance of more than 2.5 miles. It is also possible, though extremely unlikely, that a limited number of bull trout may be killed or injured during installation and dewatering of steel casings for the bridge pier that will be constructed in the mainstem Snohomish River. The project proponent does not propose to capture, remove, or exclude fish life in advance of this work due to practical, on-site constraints.

In addition to impact pile driving, the proposed action includes other construction activities within the mainstem Snohomish River, directly over or adjacent to the mainstem Snohomish River, and within the Snohomish-Skykomish floodplain, which have some potential to temporarily degrade surface water quality and thereby disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter). These activities include in-water work necessary to construct the mid-channel pier footing and column, removal of the temporary work trestle and associated piles, falsework for the bridge superstructure, and work within the floodplain (including temporary clearing, fill, haul, staging and access) to construct the four upland bridge piers and abutments. Activities that disrupt normal bull trout behavior may cause bull trout to avoid the action area, may prevent individuals from exploiting preferred habitats, and may expose them to less favorable conditions. Because suitable spawning habitats are not present in the action area, the project is not expected to interfere with bull trout reproductive behaviors.

The proposed action will have temporary adverse effects to designated bull trout critical habitat. Work conducted within or directly over the mainstem Snohomish River, including placement of temporary piles and a large over-water work trestle through two in-water construction seasons, is expected to temporarily degrade water quality and measurably affect the function of the migratory corridor.

The proposed action will have permanent adverse effects to bull trout and to designated bull trout critical habitat, principally associated with long-term (operational) stormwater effects to surface water quality and instream habitat. In addition to the long-term, indirect effects associated with the proposed stormwater design, the Service also expects that land use changes, resulting in part from the proposed action, may result in indirect effects to bull trout and their designated critical habitat. Land use changes are most likely to be focused within the City of Monroe UGA.

<u>Insignificant and Discountable Effects</u>

Some of the proposed action's potential effects to bull trout and to designated bull trout critical habitat are/will be insignificant or discountable. Effects to bull trout resulting from the following items of work are considered extremely unlikely to occur (discountable) or are not measurable or detectable (insignificant):

- Removal of temporary piles below the OHWM of the mainstem Snohomish River with the use of a vibratory hammer.
- Installation and dewatering of steel casings for the Snohomish River mid-channel pier.
- Construction activities conducted in or adjacent to minor waterbodies and wetlands.

Similarly, the following direct and indirect effects are considered extremely unlikely to occur (discountable) or are not measurable or detectable (insignificant):

- Temporal losses of wetland/buffer, floodplain, and riparian function.
- Long-term effects to surface water quality, instream habitat and/or the bull trout prey base (minor waterbodies and wetlands).
- Effect of increased impervious surface to hyporheic function, subsurface water exchange, and groundwater recharge.

One pier for the new bridge over the mainstem Snohomish River (Pier 3) will be constructed mid-channel and will require a temporary work trestle supported by steel piles. The project proposes to place and subsequently remove approximately 135 temporary steel piles during each of two in-water construction seasons. All in-water work conducted within the mainstem Snohomish River will be completed during the approved in-water work window (July 1 to September 30), and removal of the temporary pilings with a vibratory hammer is scheduled for the last month of each in-water construction season (i.e., September 1 to September 30). Vibratory hammers produce, on average, underwater peak pressures that are approximately 17 dB lower than those generated by impact hammers (Nedwell and Edwards 2002). Underwater sound produced by vibratory and impact hammers differs not only in intensity, but also in frequency and impulse energy (i.e., total energy content of the pressure wave). This may explain why no documented fish kills have been associated with the use of vibratory hammers. Most of the sound energy produced by impact hammers is concentrated at frequencies between 100 and 800 Hz, across the range thought to be most harmful to exposed aquatic organisms, while sound energy produced by vibratory hammers is concentrated between 20 and 30 Hz. In addition, sound pressures produced by impact hammers rise much more rapidly than do the sound pressures produced by vibratory hammers (Carlson *et. al.* 2001; Nedwell and Edwards 2002).

The site of the new bridge and temporary work trestle, where temporary piling would be removed with a vibratory hammer, is located in a large river system where currents contribute to ambient levels of underwater sound. Ambient levels of underwater sound have been conservatively estimated at 120 dB_{peak} (FHWA 2006) and may actually be considerably higher. The Service expects that underwater sound produced during the course of piling removal operations will not be detectable to a significant distance and that bull trout present within the action area will not be injured as a result of these operations. Similarly, the Service expects any related, temporary effects to normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter) will not be measurable and are therefore insignificant.

Constructing the mid-channel pier for the new bridge over the mainstem Snohomish River (Pier 3) will also require installation and dewatering of steel casings. Because of their small size compared to the wetted width of the channel (i.e., approximately 10 ft in diameter), and because the casings will be lowered slowly and bull trout are likely to avoid locations where over-water work is ongoing, the Service expects that no bull trout will be trapped in the casing, injured, or otherwise affected by this work. Effects to bull trout resulting from installation and dewatering of steel casings are extremely unlikely to occur and are therefore discountable.

Exposure of bull trout to construction activities conducted in or adjacent to minor waterbodies and wetlands, including all in-water work conducted below the OHWM of the two unnamed, minor tributaries to Cripple Creek, the two unnamed, minor tributaries to the Skykomish River, and associated wetlands is extremely unlikely. The minor tributaries to Cripple Creek do not provide suitable habitat for bull trout and the Service does not expect these tributaries support bull trout at any time of year. The minor tributaries to the Skykomish River may support low numbers of bull trout during some times of year (e.g., subadult and adult bull trout seeking refuge from high flows in the mainstem Snohomish and Skykomish Rivers). However, with full implementation of the proposed Conservation Measures, including adherence to the approved in-water work windows, the Service expects adult, subadult, and juvenile bull trout will not be exposed to these construction activities. Accordingly, the Service expects any related, temporary effects to bull trout are extremely unlikely to occur and are therefore discountable.

Temporal losses of wetland/buffer, floodplain, and riparian function associated with the proposed action are not expected to have a measurable or detectable effect on bull trout or their habitat. The project will replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to approved ratios, prior to or concurrent with construction of the larger project. Accordingly, the Service expects any related, temporary effects to bull trout or their habitat will be insignificant.

The proposed action includes project elements that will or may have long-term effects to surface water quality, instream habitat and/or the bull trout prey base along two unnamed, minor tributaries to Cripple Creek (French Creek basin), two unnamed, minor tributaries to the Skykomish River, and their associated wetlands. While the minor tributaries to the Skykomish River may support low numbers of bull trout, the tributaries to Cripple Creek are not expected to support bull trout at any time of year. With full implementation of the proposed Conservation Measures, the Service expects the project's incorporated permanent design elements, including retrofit for improved stormwater management and improvements to fish passage along the project corridor, will offset potential effects. Effects to surface water quality along these minor waterbodies and wetlands, to instream habitat and the bull trout prey base will not be measurable in the short- or long-term (or will be beneficial) and are therefore insignificant.

Conversion of land to impervious surface can alter the duration and frequency of runoff, can decrease both rates of infiltration and evapotranspiration, and can, in turn, influence patterns of subsurface water exchange and baseflows (May *et. al.* 1997; Beyerlein 1999; Angermeier *et. al.* 2004). At completion, the proposed action would create approximately 27.6 acres of new impervious surface (FHWA 2006). While this represents an approximately 85 percent increase to the amount already present along the project corridor (32.7 acres), less than half of the impervious surface is located within TDAs that drain or discharge to the Snohomish and Skykomish Rivers (approximately 24.8 acres). Upstream of the action area, these waterbodies have a combined drainage area of approximately 1,535 square miles (DOE 2007). The proposed action may influence patterns of runoff, infiltration, and subsurface water exchange on a local scale, but will have no discernible effect on the size or frequency of peak, high, low or base flows, or on day-to-day or seasonal fluctuations of the natural hydrograph along these portions of the Snohomish, Snoqualmie, and Skykomish Rivers. The proposed stormwater design is not expected to cause or contribute to measurable increases in surface water temperature, and will not degrade thermal refugia within the action area. Effects to bull trout, their habitat, and prey base will not be measurable in the short- or long-term and are therefore insignificant.

<u>Exposure to Elevated Underwater Sound Pressure Levels</u>

The proposed action includes construction of a new two-lane bridge over the Snohomish River, in parallel and downstream of the existing bridge (Bridge 522/138). One pier for the new bridge (Pier 3) will be constructed mid-channel in the mainstem Snohomish River over the course of two consecutive construction seasons (2010 and 2011). Gaining access to the mid-channel pier location will require construction of a work trestle supported by 24-inch diameter temporary steel piles. The project proposes to place and subsequently remove approximately 135 temporary steel piles during each of two seasons. Pilings would be installed with an impact hammer and noise attenuation device (i.e., confined bubble curtain or functional equivalent) and removed at the end of each of the two in-water work windows with a vibratory hammer. All impact pile driving within the mainstem Snohomish River will be conducted between July 1 and August 31. Impact pile driving is an intermittent activity and the project proponent expects the project will install 1-5 piles per day. Impact pile driving will be conducted intermittently on 30 or more working days during each of two construction seasons (2010 and 2011).

Bull trout may be temporarily exposed to elevated underwater sound pressure levels (SPLs) resulting from impact pile driving. Impact pile driving conducted below the OHWM of the mainstem Snohomish River has the potential to kill or injure a limited number of individuals and may also interfere with or disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter) to a distance of more than 2.5 miles.

Effects of Elevated Underwater SPLs - General

High underwater SPLs are known to have negative physiological and neurological effects on a wide variety of vertebrate species (Yelverton *et. al.* 1973; Yelverton and Richmond 1981; Turnpenny and Nedwell 1994; Hastings and Popper 2005). High underwater SPLs are known to injure and/or kill fishes, as well as cause temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny *et. al.* 1994; Popper 2003; Hastings and Popper 2005). Risk of injury appears related to the effect of rapid pressure changes, especially on gas-filled spaces in the bodies of exposed organisms (Turnpenny *et. al.* 1994). Fish-kills have been among the most noticeable and well-documented adverse effects of in-water impact pile driving. With few exceptions, however, fish-kills are generally reported only when dead or injured fish are observed at the surface and therefore the frequency and magnitude of such kills are likely underestimated. High underwater SPLs can also cause a variety of behavioral responses, many of which have not been thoroughly studied.

The effects of elevated underwater SPLs on exposed organisms can vary substantially, ranging broadly from no noticeable effect to instantaneous mortality. Over this continuum of effect, there is no easily identifiable point at which behavioral responses transition to physical effects. We examine to types of exposure to elevated SPLs; exposures causing injury and/or mortality, and exposures causing significant behavioral changes or disruption.

Effects of Elevated Underwater SPLs - Injury and Mortality

Injury and mortality in fishes has been attributed to impact pile driving (Stotz and Colby 2001; Stadler 2002; Abbott *et. al.* 2005; Hastings and Popper 2005). The injuries associated with exposure to high SPLs are referred to as barotraumas, and include hemorrhage and rupture of internal organs, hemorrhaged eyes, and temporary stunning (Yelverton *et. al.* 1973; Yelverton *et. al.* 1975; Yelverton and Richmond 1981; Turnpenny and Nedwell 1994; Hastings and Popper 2005). Death as a result of barotrauma can be instantaneous, occurring within minutes after exposure, or can occur several days later (Abbott *et. al.* 2002). Necropsy results from Sacramento blackfish (*Othodon microlepidotus*) exposed to high SPLs showed fish with extensive internal bleeding and a ruptured heart chamber were still capable of swimming for several hours before death (Abbott *et. al.* 2002). Sublethal injuries can interfere with the ability to carry out essential life functions such as feeding and predator avoidance (Popper 2003).
The potential for injury and/or mortality depends on several factors, including the type of sound and intensity of sound produced. These, in turn, are strongly influenced by the type of hammer, characteristics of the substrate and subsurface conditions, depth of water, and the presence or absence of channel (bed and bank) formations that might serve to naturally intercept and

attenuate SPLs. Firmer substrates are more resistant to penetration, generally require more force and energy when pile driving, and therefore usually produce more intense sound pressures. In addition to the type of sound and intensity of sound produced, other factors that influence the potential for injury and/or mortality include the size of the exposed organism(s), anatomical variation, and location in the water column (Gisiner *et. al.* 1998). Sound energy from an underwater source readily enters the bodies of exposed organisms because the acoustic impedance of animal tissue nearly matches that of water (Hastings 2002).

Gas-filled structures are particularly susceptible to the adverse effects of elevated underwater sound (Gisiner *et. al.* 1998). Examples of gas-filled structures found in vertebrate species include swimbladders, bowels, sinuses, and lungs. As sound travels from a fluid medium into a gas-filled structure there is a dramatic drop in pressure, which can cause rupture of the hollow organs (Gisiner *et. al.* 1998). This has been demonstrated in fishes with swimbladders (including salmonids). As a sound pressure wave passes through a fish, the swimbladder is rapidly compressed due to the high pressure and then rapidly expanded by the underpressure. Exposure to this type of "pneumatic pounding" can cause rupture of capillaries in the internal organs, as observed in fishes with blood in the abdominal cavity, and maceration of kidney tissues (Abbott *et. al.* 2002; Stadler 2002).

Yelverton and Richmond (1981) and Yelverton *et. al.* (1973) exposed a variety of fish species, various birds, and terrestrial mammals to underwater explosions. Common to all the species were injuries to air- and gas-filled organs, as well as eardrums. These studies identified injury thresholds in relation to the size of the charge, the distance at which the charge was detonated, and the mass of the exposed animal. Yelverton *et. al.* (1973) and Yelverton and Richmond (1981) found that the greater the fish's mass, the greater impulse level needed to cause an injury. Conversely, a fish with smaller mass would sustain injury from a smaller impulse.

At Bremerton, Washington, approximately 100 surfperch (*Cymatogaster aggregata, Brachyistius frenatus* and *Embiotoca lateralis*) were killed during impact driving of 30-inch diameter steel pilings (Stadler 2002). The size of these fish ranged from 70 mm to 175 mm fork length. Dissections revealed that the swimbladders of the smallest of the fishes (80 mm fork length) were completely destroyed, while those of the largest individual (170 mm fork length) were nearly intact. Damage to the swimbladder of *C. aggregata* was more severe than to similar-sized *B. frenatus*. These results are suggestive of size and species-specific differences and are consistent with those of Yelverton *et. al.* (1975) who found size and/or species differences in injury from underwater explosions.

Another mechanism of injury and mortality resulting from high SPLs is "rectified diffusion", or the formation and growth of bubbles in tissue. Rectified diffusion can cause inflammation and cellular damage because of increased stress and strain (Vlahakis and Hubmayr 2000; Stroetz *et. al.* 2001) and blockage or rupture of capillaries, arteries, and veins (Crum and Mao 1996). Crum and Mao (1996) analyzed bubble growth caused by sound signals at low frequencies (less than 5,000 Hz), long pulse widths, and atmospheric pressure. Their analysis indicates that underwater SPLs exceeding 190 dB_{peak} can cause bubble growth.

Due to differences between species and from variation in exposure type and duration, uncertainty remains as to the degree of potential adverse effect from SPLs between 180 and 190 dB_{peak}. Turnpenny *et. al.* (1994) exposed brown trout (*Salmo trutta*) to SPLs greater than 170 dB using pure tone bursts for a duration of 90 seconds. This resulted in a mortality rate of 57 percent (after 24 hours) in brown trout; 50 percent mortality (after 24 hours) was observed in bass (*Dicentrarchus labrax*) and whiting (*Merlangius merlangus*) exposed to SPLs greater than 176 dB. The authors suggest that the threshold for continuous sounds is, or ought to be, lower than for pulsed sounds, such as seismic airgun blasts. Sound pressures produced by impact pile driving are more similar to those produced by airgun blasts. As such, we conclude that the 170 dB threshold for injury to brown trout identified by Turnpenny *et. al.* is likely lower than the injury threshold associated with underwater SPLs produced by impact pile driving.

Based on the studies and findings referenced above, the Service expects that juvenile, subadult, and adult bull trout exposed to SPLs equal to or in excess of 190 dB_{peak} will or may experience barotraumas resulting in mortality. We expect other types of physical injury are likely to occur when bull trout are exposed to SPLs above 180 dB_{peak}. The 180 dB_{peak} threshold is probably somewhat conservative because most of the studies described above evaluated elevated SPLs of longer duration than are expected to result from impact pile driving.

Effects of Elevated Underwater SPLs - Behavioral Responses

Elevated underwater SPLs can elicit a variety of behavioral responses. In general, there is much uncertainty regarding the response of organisms to sources of underwater sound, and there are no experimental data specific to bull trout exposed to underwater sound from impact pile driving. Further confounding the issue, most of the information on behavioral effects of underwater sound is obtained from studies examining pure tone sounds. Sounds generated by impact pile driving are impulsive and are made up of multiple frequencies/tones, making comparisons with existing data difficult.

Knudsen *et. al.* (1992) studied spontaneous awareness reactions (consisting of reduced heart beat frequency and opercular movements), and avoidance responses to sound in juvenile Atlantic salmon. This study evaluated responses to frequencies ranging from 5 to 150 Hz. With increasing frequency, the difference between the threshold for spontaneous awareness reaction and the estimated hearing threshold also increased. At 5, 60 and 150 Hz, the signal had to exceed the hearing thresholds by 25, 43 and 73 dB, respectively, to elicit reactions. Most of the sound energy produced by impact pile hammers is concentrated at frequencies between 100 and 800 Hz. Salmonids can detect sounds at frequencies between 10 Hz (Knudsen *et. al.* 1997) and 600 Hz (Mueller *et. al.* 1998). Optimal salmonid hearing is thought to be at frequencies of 150 Hz (Hawkins and Johnstone 1978). Therefore, impact pile installation produces sounds within the range of salmonid hearing.

Exposure to elevated SPLs can result in temporary hearing damage referred to as Temporary Threshold Shift (TTS). Most bioacoustic specialists consider TTS to be physiological fatigue and not injury (Popper *et. al.* 2006). However, an organism experiencing TTS may be unable to detect biologically relevant sounds such as approaching predators or prey, and/or mates attempting to communicate. Mesa (1994) examined predator avoidance ability and physiological response of Chinook salmon subjected to various stressors. Test subjects were agitated to cause disorientation. When equal numbers of stressed and unstressed fish were exposed to predators, there was significantly more predation of stressed fish. Shin (1995) reports that impact pile driving may result in agitation of fish, manifested as a change of swimming behavior.

Turnpenny *et. al.* (1994) attempted to determine a level of underwater sound that would elicit behavioral responses in brown trout, bass, sole, and whiting. In brown trout an avoidance reaction was observed above 150 dB_{rms}, and other reactions (e.g., a momentary startle) were observed at 170-175 dB_{rms}. The report references Hastings' "safe limit" recommendation of 150 dB_{rms} and concludes that the Hastings' "safe limit" provides a reasonable margin below the lowest levels where fish injury was observed. In an associated literature review, Turnpenny and Nedwell (1994) also state that the Hastings' 150 dB_{rms} limit did not appear overly stringent and that its application seemed justifiable.

More recently, Fewtrell (2003) held fish in cages in marine waters and exposed them to seismic airgun impulses. The study detected significant increases in behavioral response when sound pressure levels exceeded 158-163 dB_{rms}. Responses included alarm, faster swimming, tighter grouping, and movement toward the lower portion of the cage. It is difficult to discern the significance of these behavioral responses. The study also evaluated physiological stress response by measuring plasma cortisol and glucose levels and found no statistically significant changes. Conversely, Santulli *et. al.* (1999) found evidence of increased stress hormones after exposing caged European bass to seismic survey noise.

Popper (2003) suggests that the behavioral responses of fishes may include swimming away from the sound source, thereby decreasing potential exposure to the sound, or "freezing" (staying in place), thereby becoming vulnerable to possible injury. Feist *et. al.* (1992) found that impact pile driving affected juvenile pink and chum salmon distribution, school size, and schooling behavior. In general, on days when impact pile driving was not conducted, fish exhibited a more polarized schooling behavior (i.e., movements in a more definite pattern). On days when impact pile driving was conducted, fish exhibited an active "milling" behavior (i.e., movement in an eddying mass); fish did appear to change their distributions about the site, more commonly orienting and moving towards an acoustically-isolated cove, on days when impact pile driving was conducted. Observations by Feist *et. al.* (1992) suggest that SPLs in excess of 150 dB_{rms} may disrupt normal migratory behavior in juvenile salmon.

Clearly, there is a substantial gap in scientific knowledge on the topic of significant behavioral responses to elevated underwater SPLs. The most recent study by Fewtrell (2003) presents some experimental data on behavioral responses of fishes to impulsive sounds above 158 dB_{rms}. However, given the large amount of uncertainty that lies not only in extrapolating from experimental data to the field, but also between sound sources (airguns vs. pile driving), and from one species to another, the Service believes it is appropriate to utilize the most conservative known threshold. As such, for the purposes of this analysis, the Service expects that SPLs in excess of 150 dB_{rms} will cause significant behavioral changes in bull trout and will or may disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter).

Air Bubble Noise Attenuation Systems

Air bubble noise attenuation systems (or bubble curtains) have been used successfully to limit the intensity and/or extent of underwater sound (Gisiner *et. al.* 1998). Air bubbles are most effective at moderate to high frequencies, but are also useful for low frequency sounds and have been shown to reduce SPLs at some frequencies by as much as 30 dB (Gisiner *et. al.* 1998). During demolition of a dam on the Mississippi River, Keevin *et. al.* (1997) were successful in achieving a significant reduction in mortality of caged bluegill (*Lepomis macrochirus*) with the use of a bubble curtain. Bubble curtains can also reduce particle velocity levels (MacGillivray and Racca 2005).

In recent years, air bubble noise attenuation systems have been required and implemented on an increasing number of pile installation projects, primarily on the west coast. Designs have varied and are largely experimental. Effectiveness has also varied widely and is likely to be influenced by factors such as design, site conditions, and the ability of construction contractors to correctly implement the system. Improper installation or operation can decrease effectiveness. Problems with implementation have been observed on a number of projects (Laughlin 2005; Pommerenck 2006).

There are a number of examples that may be used to illustrate variation in the performance of air bubble noise attenuation systems and the influence of design, site conditions, and implementation. An attenuation system consisting of an isolation casing with an inside bubble curtain was used to reduce peak SPLs by 6-9 dB when conducting impact pile driving in the San Joaquin River (Pommerenck 2006); it appears this system faced complications during implementation. During impact installation of steel piles in an embayment on the Columbia River, a bubble curtain built using the Longmuir and Lively design (2001) achieved a maximum reduction of 17 dB, although results were variable (Laughlin 2006). A test of bubble curtain effectiveness in Friday Harbor, Washington, found improvements were seen after the original design was modified on-site to improve contact with the substrate. After modification, the bubble curtain achieved a 12 dB reduction, which equates to an 85 percent reduction in peak overpressure (Laughlin 2005). Use of a bubble curtain while installing 24-inch diameter steel piles at a marina in Washington resulted in reductions of 10-15 dB (Houghton and Smith 2005). Despite significant variation in performance, when properly implemented bubble curtains can achieve reductions in peak SPLs and thereby limit the extent of potential adverse effects to aquatic organisms.

Estimate of the Extent of Effect

The Service uses SPLs measured as peak pressure to define the onset of injury. In 2004, the California Department of Transportation and the FHWA convened a group of experts in the field of underwater acoustics (referred to as the Fisheries Hydroacoustic Working Group) with the intent of evaluating and potentially refining criteria. This effort included an extensive literature review as the basis for a report on the topic (Hastings and Popper 2005) and a white paper proposing interim criteria (Popper *et. al.* 2006). The Hastings and Popper report (2005) suggests that a metric of Sound Exposure Level (SEL) may be more appropriate for assessing potential injury to fishes from impact pile driving; in part, because the use of SEL allows for the summing of energy over multiple pile driving pulses, which cannot be accomplished when using peak pressure. However, until there is agreement regarding accurate methods for determining the accumulation of energy from multiple pile strikes and the resultant effect on fishes, the Service continues to use a peak SPL metric to define the onset of expected injury.

The practical spreading model (Davidson 2004) may be used to estimate the distance from piling installation operations (R; range) at which transmission loss (TL) can be expected to attenuate peak pressures to below thresholds for injury and significant behavioral interference or disruption, 180 dB_{peak} and150 dB_{rms} respectively. The calculation [TL = 15*Log(R)] assumes that SPLs decrease at a rate of 4.5 dB per doubling distance. Based on information provided in the BA, the Service also assumed unattenuated peak pressures of 211 dB_{peak} and 196 dB_{rms} (measured at 10 meters), and a 5 dB reduction with the use of an air bubble noise attenuation system (FHWA 2006). These assumptions regarding unattenuated peak pressures are within the range reported in the literature for similar operations (i.e., similar methods for piling installation, similar pile diameters, etc.) (USFWS 2007).

Based on the studies and findings presented in previous sub-sections, injury is expected at SPLs greater than or equal to 180 dB_{peak}. Applying the methods of analysis summarized here, SPLs exceeding thresholds that can result in bull trout injury or mortality are expected to extend to a distance of approximately 1,775 ft. [Note: when collecting real-time data to describe unattenuated peak pressures (i.e., for the purpose of assessing performance of the confined bubble curtain or functional equivalent), the project will conduct a limited number of "test" strikes without use of a noise attenuation device. When conducting "test" strikes, SPLs exceeding thresholds that can result in bull trout injury or mortality are expected to extend to a distance of approximately 3,825 feet.] Low numbers of foraging and migrating juvenile, subadult, and adult bull trout are expected in the action area at the time of construction, will be exposed to SPLs in excess of 180 dB_{peak}, and may be injured or killed as a result of exposure.

Similarly, when conducting impact pile driving and proofing with a noise attenuation device, SPLs exceeding thresholds associated with significant behavioral interference or disruption are expected to extend to a distance of at least 17,500 ft (3.3 miles). However, this distance does not take into account the presence of channel features (e.g., point bars, banks, and river meanders) which may intercept and thereby attenuate underwater sound pressure levels. After taking these features into account, the Service expects SPLs exceeding thresholds associated with significant behavioral disruption will extend to a distance of at least 1 mile in an upstream direction, and to a distance of at least 2.6 miles in a downstream direction (See Figure 6, page 37).

Low numbers of foraging and migrating juvenile, subadult, and adult bull trout are expected in the action area at the time of construction, will be exposed to SPLs in excess of 150 dB_{rms}, and may experience interference with their normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter). Use of the action area may be precluded while impact pile driving and proofing is ongoing. Impact pile driving and proofing may prevent bull trout from moving freely though the action area and may temporarily displace bull trout from preferred habitats (including deep pool thermal refugia). Because suitable spawning habitats are not present in the action area, impact pile driving and proofing is not expected to interfere with bull trout reproductive behaviors.

Exposure to Elevated Turbidity and Sedimentation During Construction

The proposed action includes construction activities within the mainstem Snohomish River, directly over or adjacent to the mainstem Snohomish River, and within the Snohomish-Skykomish floodplain. These activities are expected to temporarily degrade surface water quality and disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter). These activities include in-water work necessary to construct the mid-channel pier footing and column, removal of the temporary work trestle and associated piles, metalwork preparation and painting, falsework for the bridge superstructure, and work within the floodplain (temporary clearing, fill, haul, staging and access) to construct the four additional bridge piers and abutments.

While work conducted below the OHWM of the mainstem Snohomish River would be completed during approved in-water work windows, many of the other above-mentioned items of work could be conducted during other times of year. The project proposes to construct and maintain a temporary haul road(s) within the Snohomish-Skykomish floodplain for use during multiple seasons of construction (2010, 2011, and perhaps during additional seasons), and current construction sequencing has most work over or adjacent to the mainstem Snohomish River and Snohomish-Skykomish floodplain tentatively scheduled for July through December 2010 and July 2011 through February 2012 (FHWA 2006).

Even with full implementation of the agreed upon Conservation Measures, the Service expects that work conducted over, or adjacent to, the mainstem Snohomish River and Snohomish-Skykomish floodplain is likely to cause or contribute to short-term, episodic increases in turbidity and sedimentation. Given the amount, timing, and duration of such work, exposure of adult, subadult, and juvenile bull trout is not discountable. Bull trout may be exposed to increases in turbidity and sedimentation sufficient to temporarily disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter).

Work conducted during the fall, and early- to mid-winter (i.e., November through February) probably poses the greatest risk of exposure because of extremes of both precipitation and discharge. The WSDOT has documented inundation of the floodplain immediately below Bridge 522/138 in response to a 1- to 2-year flood event and estimates that a 100-year flood event could increase depths immediately below the bridge to more than 10 ft (WSDOT 2003).

Although few studies have specifically examined the issue as it relates to bull trout, increases in suspended sediment affect salmonids in several recognizable ways. The variety of effects of suspended sediment may be characterized as lethal, sublethal or behavioral (Bash *et. al.* 2001; Newcombe and MacDonald 1991; Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash *et. al.* 2001). Sublethal effects include physiological stress reducing the ability of fish to perform vital functions (Cederholm and Reid 1987), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash *et. al.* 2001), and reduced feeding efficiency (Bash *et. al.* 2001; Berg and Northcote 1985; Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash *et. al.* 2001). Fish may be forced to abandon preferred habitats and refugia, and may enter less favorable conditions and/or be exposed to additional hazards (including predators) when seeking to avoid elevated concentrations of suspended sediment.

In order to assess the suspended sediment concentrations at which adverse effects will occur and to determine the downstream extent to which these effects may extend as a result of the proposed project, the Service used the analytical framework attached as Appendix A (USFWS 2006). This framework uses the findings of Newcombe and Jensen (1996) to evaluate the "severity-of-effect" (SEV) based on suspended sediment concentration, exposure, and duration. Factors influencing suspended sediment concentration, exposure, and duration include waterbody size, volume of flow, the nature of the construction activity, construction methods, erosion controls, and substrate and sediment particle size. Factors influencing the SEV include duration and frequency of exposure, concentration, and life stage. Availability and access to refugia are other important considerations.

It is difficult to predict the suspended sediment concentrations that may result temporarily from construction of the proposed project. The substrates of the mainstem Snohomish River and Skykomish River side-channel are dominated by coarse sand intermixed with large cobble (FHWA 2006; WSDOT 2003). Data collected at monitoring stations on the Skykomish and Snoqualmie Rivers indicate that TSS concentrations are typically very low during low flow summer months and, on average, not too greatly increased during winter months. Mean winter (October 1 – April 30) TSS, derived from more than 25 years of monitoring data (DOE 2007), is approximately 11 mg/L and 19 mg/L at the Skykomish and Snoqualmie monitoring stations respectively. Events resulting in TSS measures in excess of 50 mg/L are uncommon, but across a range of flows approximating the annual average peak discharge (i.e., approximately 65,000 cfs) TSS has ranged from 90 to 260 mg/L (DOE 2007c).

The framework in Appendix A requires an estimate of suspended sediment concentration (mg/L) and exposure duration. Monitoring data collected at the WDOE station in closest proximity (DOE 2007c) was used to determine the ratio of turbidity to suspended solids (1 NTU : 2.21 mg/L). To determine exposure duration, the Service assumed that in-water and over-water work would occur during business hours, 10 hours a day, for as many as 250 working days. It is important to note the Service expects that any measurable increases in turbidity will be short-term (i.e., less than three days) and episodic.

Using this approach, we expect that adverse effects to bull trout resulting from work conducted within the mainstem Snohomish River, directly over or adjacent to the mainstem Snohomish River, and/or within the Snohomish-Skykomish floodplain, are likely to occur under the following circumstances:

1. When background NTU levels are exceeded by 67.0 NTUs at any point in time.
2. When background NTU levels are exceeded by 24.9 NTUs for more than 1 hour, cumulatively, over a 10-hour workday.

3. When background NTU levels are exceeded by 9.0 NTUs for more than 7 hours, cumulatively, over a 10-hour workday.

To assess the potential extent of these effects we relied on a limited set of monitoring data collected to determine the effectiveness of BMPs and compliance with State surface water quality standards (Appendix A; Table 5). These data provide evidence that water quality standards for turbidity are exceeded in some instances, even with the use of BMPs. Based on this information and the size of the "receiving" waterbody, the Service expects that suspended sediment concentrations resulting in adverse effects to bull trout are reasonably certain to occur as far as 300 ft downstream of construction activities. Suspended sediment concentrations resulting in adverse effects to bull trout are expected to extend from a point approximately 100 ft upstream of the Snohomish River crossing, to a point approximately 300 ft downstream of the crossing.

Adult, subadult, and juvenile bull trout are expected to avoid the in-water work area and immediate vicinity of the Snohomish River crossing when elevated suspended sediment concentrations result from construction activities. Use of the area may be precluded until suspended sediment concentrations diminish. These exposures may result in short-term, intermittent disruptions to normal bull trout behavior (i.e., ability to successfully feed, move and/or shelter), including, but not limited to, use of deep pool thermal refugia. Elevated concentrations of suspended sediment may intermittently prevent bull trout from moving freely though portions of the action area (i.e., from 100 feet upstream, to a point approximately 300 ft downstream of the Snohomish River crossing). Some individuals may experience sublethal effects including physiological stress, increased metabolic oxygen demand, reduced feeding efficiency, and/or the other sublethal effects that are discussed in greater detail in Appendix A. Because suitable spawning habitats are not present in the action area, temporary increases in suspended sediment concentration resulting from work conducted within the mainstem Snohomish River, directly over or adjacent to the mainstem Snohomish River, and/or within the Snohomish-Skykomish floodplain are not expected to interfere with bull trout reproductive behaviors.

Operational (Stormwater) Effects to Surface Water Quality and Instream Habitat

The proposed action is expected to have adverse effects to bull trout associated with long-term (operational) discharge of treated highway stormwater runoff. Resulting effects to surface water quality will last in perpetuity. In addition, land use changes may result, in whole or in part, from the proposed project and could result in similar effects. Potential indirect effects to the aquatic environment associated with land use changes are detailed in a sub-section that follows (Indirect Effects, Land Use Changes and Related Effects to the Environment).

The receiving waters in the action area are at risk for the contamination indicator. However, with the exception of an upstream portion of the Snoqualmie River listed for fecal coliform, no portion of the action area is currently listed for routine violation of State surface water quality standards. The 1998 303(d) list identified a downstream portion of the Snohomish River as an impaired waterbody for exceedances of metals criteria (WDOE 1999). However, the WDOE conducted additional sampling between 2000 and 2002 and has since concluded this segment of the Snohomish River currently meets criteria for arsenic, chromium, Cu, lead, mercury, nickel, silver, and Zn (WDOE 2005a).

At completion, the proposed action would create approximately 27.6 acres of new PGIS. This represents an approximately 85 percent increase to the amount of existing PGIS in the project corridor. The proposed action includes a stormwater design expected to achieve significant reductions in post-project pollutant loading and discharge concentrations. However, for some contaminants of concern (e.g., dissolved metals) loadings are expected to increase in one or more TDAs, and effluent concentrations are expected to exceed thresholds associated with adverse sublethal effects to salmonids and bull trout.

The project proposes to construct flow control facilities to detain and moderate peak stormwater flows from four of the six TDAs (3-6). The project will seek flow control exemptions from the WDOE for direct discharge of treated stormwater from two TDAs (1 and 2). At completion, the project will direct discharge treated stormwater runoff to the side-channel of the Skykomish River in the immediate vicinity of Bridge 522/138, and to a minor tributary to the Skykomish River [07-0814(d)] approximately 5,000 feet "upstream" of this same side-channel.

Flow control facilities designed according to the WSDOT's Highway Runoff Manual (WSDOT 2006b), including the large facilities proposed for TDAs 3-6, are expected to fully infiltrate runoff from most storm events, and to discharge on an infrequent basis (i.e., events exceeding the 6-month storm event) (FHWA 2006). The WSDOT is refining hydraulic analyses in support of the flow control exemptions sought for direct discharge of treated stormwater in TDAs 1 and 2. These analyses are preliminary, but suggest that direct discharge will not cause, or contribute to, erosion downstream of the proposed "treatment-only" facilities (Ponds 3A and 4A) (FHWA 2006).

Stormwater Pollutants / Contaminants of Concern

Untreated highway runoff contains a variety of pollutants which can impair water quality and pose a risk to aquatic organisms (Herrera 2007). Table 5 identifies the variety of pollutants typically found in untreated highway runoff.

Sources of pollutants found in untreated highway runoff include atmospheric deposition, direct and indirect deposition and application, and vehicles and vehicular traffic (Herrera 2007).

Table 5. Typical pollutants in highway runoff (Herrera 2007).

Pollutant Parameter Category	Parameter
Suspended Solids	Total suspended solids
	Volatile suspended solids
Metals	Arsenic
	Cadmium
	Chromium
	Copper
	Iron
	Lead
	Mercury
	Nickel
	Zinc
Nutrients	Ammonia nitrogen
	Nitrate nitrogen
	Total Nitrogen
	Total Kjeldahl nitrogen
	Total Phosphorus
	Orthophosphate phosphorus
Organic Compounds	Polycyclic aromatic hydrocarbons
	Oil and grease
	Total petroleum hydrocarbons
	Pesticides
	Herbicides
Bacteria	Total coliform bacteria
	Fecal coliform bacteria
Oxygen Demand	Biological oxygen demand (5-day)
	Chemical oxygen demand
Conventional Parameters	Sodium (if deicing performed)
	Chloride (if deicing performed)
	pH
	Turbidity
	Conductivity Hardness

Factors that influence the types and amounts of pollutants found in untreated highway runoff include rates of use (ADT) and traffic conditions, weather and precipitation patterns, road conditions and maintenance, and adjoining and surrounding land uses. One particularly important factor is the buildup of solids and other pollutants on pavement and in stormwater conveyances between storm events (Herrera 2007).

Data obtained from a variety of sources indicate that pollutant concentrations in untreated highway runoff are highly variable (Herrera 2007). Table 6 reports mean pollutant concentrations obtained from studies examining highway runoff in western Washington and nationwide.

Table 6. Constituents in untreated highway runoff (Herrera 2007): comparison of site mean concentrations.

Constituent	Western Washington Sites [a]	National Data [b]
Solids (mg/L)		
Total	No data	437 to 1,147
Dissolved	No data	356
Suspended	3 to 295 (27)	45 to 798
Volatile (dissolved)	No data	131
Volatile (suspended)	19 to 460 (5)	4.3 to 79
Volatile (total)	No data	57 to 242
Metals, total (µg/L)		
Antimony	1.2 to 8.7 (2)	Not reported
Arsenic	2.2 to 2.6 (2)	58
Barium	81 to 84 (2)	Not reported
Chromium	7.5 to 18 (2)	Not detected to 40
Cadmium	0.9 to 2.8 (2)	Not detected to 40
Cobalt	1.9 to 4.4 (2)	Not reported
Copper	4.6 to 72 (29)	22 to 7,033
Iron	No data	2,429 to 10,300
Lead	24 to 1,065 (10)	73 to 1,780
Lead[c]	24 to 61 (3)	73 to 1,780
Magnesium	No data	1,062
Mercury	0.02 (1)	3.22
Molybdenum	1.5 to 9.5 (2)	Not reported
Nickel	8.6 to 12.9 (2)	53
Vanadium	6.3 to 14.8 (2)	Not reported
Zinc	26 to 394 (29)	56 to 929
Metals, dissolved (µg/L)		
Copper	3.1 to 18.1 (21)	Not reported
Lead	1.0 to 3.2 (2)	Not reported
Lead[c]	3.2 (1)	Not reported
Zinc	13 to 134 (22)	Not reported
Nutrients (mg/L)		
Ammonia nitrogen	1.0 to 2.7 (2)	0.07 to 0.22
Nitrite nitrogen	No data	0.013 to 0.25
Nitrate nitrogen	No data	0.306 to 1.4
Nitrite+nitrate nitrogen	0.51 to 3.0 (6)	0.15 to 1.636
Organic nitrogen	No data	0.965 to 2.3
Total Kjeldahl nitrogen	0.38 to 3.4 (6)	0.335 to 55.0
Total nitrogen	0.78 to 21.7 (2)	4.1
Orthophosphate phosphorus	0.01 to 0.42 (9)	Not reported
Total phosphorus	0.03 to 0.57 (24)	0.113 to 0.998

Table 6 (continued). Constituents in untreated highway runoff (Herrera 2007).

Constituent	Western Washington Sites [a]	National Data [b]
Organic Compounds (mg/L)		
TPH-oil	0.42 to 7.9 (12)	Not reported
TPH-diesel	Not detected to 2.75 (8)	Not reported
Oil and grease	11.8 to 187 (4)	2.7 to 27
Bacteria		
Total coliform bacteria (CFU/100 mL)	9,350 (1)	570 to 6,200
Fecal coliform bacteria (CFU/100 mL)	35 to 11,775 (16)	50 to 590
E. coli bacteria (CFU/100 mL)	130 to 1,670 (3)	Not reported
Oxygen Demand (mg/L)		
Chemical oxygen demand	32 to 1377 (11)	14.7 to 272
Biological oxygen demand (5-day)	9.5 to 71 (2)	12.7 to 37
Conventionals		
pH	5.8 to 6.8 (5)	7.1 to 7.2
Specific conductivity (µS at 25 °C)	71.6 (1)	337 to 500
Total organic carbon (mg/L)	2.0 to 139.0 (8)	24 to 77
Turbidity (NTU)	16.3 to 86.7 (3)	19
Hardness (mg/L as $CaCO_3$)	11.1 to 86.1 (19)	Not reported
Alkalinity (mg/L as $CaCO_3$)	19.3 to 23.4 (2)	Not reported

Highways can be significant contributors to overall pollutant loads in receiving waterbodies (Wheeler *et. al.* 2005). Pollutants that are dissolved in, or mobilized by highway runoff can be easily transported to wetlands, streams, and rivers if the runoff is not intercepted and "passively" treated by vegetation, if not infiltrated, or captured and conveyed to engineered treatment systems.

Baseline Conditions and Performance of the Proposed Stormwater Design

There are a variety of engineered stormwater treatment systems and technologies, all of which vary with regard to which pollutants or pollutant categories they are best capable of removing/treating, and the efficiencies or effectiveness with which they remove/treat specific pollutants. Treatment efficiency and effectiveness depend both on the specific treatment systems and technologies employed, and on how well these systems are designed, operated, and maintained. Studies indicate significant variation among different treatment technologies and facilities (Schueler 1987; Young *et. al.* 1996; WSDOT 2006c).

Eastern portions of the project corridor (i.e., TDAs 4-6), from and including the 164th Street SE/Tester Road surface arterial interchange to the reconstructed SR 522 / US 2 interchange, are located entirely within incorporated city limits (City of Monroe). Much of the action area east of the 164th Street SE/Tester Road interchange is developed for residential and commercial uses and has a high percentage of impervious surface by area. These portions of the project corridor drain to receiving waters that do not provide suitable habitat for bull trout and are not expected to support bull trout at any time of year (i.e., the two heavily degraded unnamed, minor tributaries to Cripple Creek). The Service does not expect bull trout will be exposed to increases in stormwater pollutants originating from TDAs 4-6.

Western portions of the project corridor (i.e., TDAs 1-3) drain to the Snohomish River and to two unnamed, minor tributaries to the Skykomish River. Both of the minor tributaries drain and discharge to the Skykomish River side-channel located on the right bank immediately upstream of the existing Snohomish River crossing (Bridge 522/138). Figures 3-5, presented in a previous section (Description of the Proposed Action; pages 10-12), identify TDA boundaries, and the locations of proposed stormwater facilities and points of discharge (outfalls). The project proposes to construct and operate in perpetuity two new stormwater outfalls (TDAs 2 and 3) which discharge to receiving waters that support low numbers of juvenile, subadult, and adult bull trout during some times of year. In addition, the project will construct and operate in perpetuity a third outfall (TDA 1) which will discharge directly to the Skykomish River side-channel, immediately upstream of the point where it enters the mainstem Snohomish River. Bull trout may be exposed to increases in stormwater pollutants originating from TDAs 1-3. In particular, increases in post-project annual loadings of dissolved Zn, total and dissolved Cu, coupled with reduced (but still elevated) effluent/discharge metal concentrations, are expected to adversely affect bull trout.

In TDA 1 post-project annual loadings of dissolved Zn, total Cu, and dissolved Cu are expected to increase by approximately 73 percent (from 1.28 to 2.22 lbs.), by approximately 12.5 percent (from 0.64 to 0.72 lbs.), and by approximately 130 percent (from 0.17 to 0.39 lbs.) respectively. In TDA 2 post-project annual loadings of dissolved Zn and dissolved Cu are expected to increase by approximately 3.7 percent (from 2.12 to 2.20 lbs), and by approximately 39 percent (from 0.28 to 0.39 lbs.) respectively. Post-project annual loadings of dissolved Cu are expected to increase by approximately 29 percent (from 0.07 to 0.09 lbs.) in TDA 3. Post-project treated effluent concentrations are expected to be 40 μg/L total Zn, 27 μg/L dissolved Zn, 7 μg/L total Cu, and 5 μg/L dissolved Cu at the points of discharge from TDAs 1-3 (Table 2).

Stormwater Effects on Fish Physiology and Behavior – General

Stormwater pollutants can affect the physiology and/or behavior of salmonids in ways that reduce growth, migratory success, and reproduction, and in sufficient concentrations can result in acute toxicity and death. Effects to aquatic life are influenced by the size and dilution capacity of the receiving waterbody, background water quality conditions, concurrent discharges and/or background levels of other contaminants, frequency and duration of exposure, concentration and relative toxicity of the pollutant(s), biological uptake and availability, and life stage. Two areas of emerging interest and concern include the potential effects of exposure to sporadic pulses of contaminants and the complicated biological responses and consequences of exposure to contaminant/pollutant mixtures (e.g., synergistic effects)(Burton *et. al.* 2000). Burton *et. al.* (2000) warn that traditional toxicity tests may not lead to reliable predictions or conclusions if not tailored to reflect "real-world" patterns of exposure.

The Service relies on toxicity data for other salmonids when specific information on toxicity to bull trout is not available. Due to taxonomic similarity, species in the Salmonidae family are expected to be better surrogates for bull trout than non-salmonids. However, Hansen *et. al.*

(2002) demonstrate that even among the members of Salmonidae specific sensitivities to chemical contaminants and mixtures of contaminants may differ. The Service has relied on toxicity data for species in the following preferential order: species (bull trout) > genus (Salvelinus) > family (Salmonidae). Rainbow trout are the primary freshwater fish species used by the Environmental Protection Agency (EPA) when developing toxicity data for regulatory purposes; therefore, the majority of data available in the literature have been generated from studies using rainbow trout as test subjects (family Salmonidae).

The most commonly reported end points in the toxicity literature are concentrations at which 50 percent of the test subjects/population died (LC50). Concentrations that result in the death of a smaller percentage of the test population (e.g., LC10) are likely to be somewhat lower. Bull trout and other salmonids would be adversely affected if exposed to lethal concentrations with the potential to result in acute toxicity and death, or if exposed to contaminant concentrations known to result in sublethal effects with consequences for normal behavior (i.e., effects that disrupt the ability to successfully feed, move, and/or shelter).

A variety of stormwater pollutants exhibit toxic mechanisms of action, including volatile organic compounds, organic herbicides and pesticides, and metals. While volatile organics and organic herbicides and pesticides may be present in untreated highway runoff at concentrations sufficient to cause adverse effects (Van Metre *et. al.* 2000; Kayhanian *et. al.* 2003), for the purpose of this consultation it is assumed that, over the long-term operation of the proposed highway improvements, metals originating from vehicular sources pose the greatest risk of lethal and sublethal effects to bull trout. Traffic residues contain several metals with toxic mechanisms of action, including iron, Zn, lead, cadmium, nickel, Cu, and chromium (Wheeler *et. al.* 2005). These metals originate from disintegrating tires, brake pads, and other vehicle parts and frequently accumulate in roadside dust and soil (Wheeler *et. al.* 2005).

Stormwater Effects on Fish Physiology and Behavior – Metals

There are three known physiological pathways by which salmonids may be exposed to and/or may uptake metals: 1) uptake of ionic metals at the gill surfaces (Niyogi *et. al.* 2004), 2) dietary uptake, and 3) olfaction (sense of smell) involving receptor neurons (Baldwin *et. al.* 2003). Of these three pathways, the mechanism of dietary uptake is least understood. For dissolved metals, the most direct pathway is through the gill surfaces.

Measurements of total recoverable metal concentration include a fraction that is bound to suspended solids and/or complexed with organic matter or other ligands; this fraction is not available to bind to gill receptor sites. As such, most metal toxicity studies have examined the dissolved metal fraction which is more bio-available and therefore of greater significance for exposure and toxicity. However, metals bound to sediment remain biologically relevant because they may be incidentally ingested and/or may be accumulated in the tissues of prey species (e.g., benthic organisms).

The relative toxicity of a metal (or metal species) can be altered by hardness, water temperature, pH, organic content, phosphate concentration, suspended solid concentration, the presence of other metals or contaminants (i.e., synergistic effects), and other factors. Eisler (1998) and

Playle (2004) found that dissolved metal mixtures exhibit greater than additive toxicity. Water hardness affects the bio-available fraction of metals; as hardness increases, metals become less bio-available for uptake at the gill surfaces and therefore less toxic (Hansen *et. al.* 2002; Niyogi *et. al.* 2004). However, Baldwin *et. al.* (2003) found water hardness did not influence the inhibiting effects of Cu on salmon olfactory functions.

Copper (Cu)

Even at low concentrations, Cu is acutely toxic to fish. Effects of Cu exposure include 1) weakened immune function and impaired disease resistance, 2) impaired respiration, 3) disruptions to osmoregulation, 4) impaired function of olfactory organs and brain, 5) altered blood chemistry, 6) altered enzyme activity and function, and 7) pathology of the kidneys, liver, and gills (Eisler 1998).

Sprague (1964) and Sprague and Ramsay (1965) reported Incipient Lethal Levels for dissolved Cu of 48 μg/L and 32 μg/L at water hardnesses of 20 and 14 mg/L, respectively. The Incipient Lethal Level is that concentration which is required to kill half of the fish tested within 1 week of exposure. Sprague and Ramsay (1965) found that higher concentrations of Cu killed juvenile salmon much more rapidly than did lower concentrations at 14 mg/L hardness.

Baldwin *et. al.* (2003) found that short pulses of dissolved Cu, at concentrations as low as 2 μg/L, reduced olfactory sensory responsiveness by approximately 10 percent within 10 minutes, and by 25 percent within 30 minutes. At 10 μg/L responsiveness was reduced by 67 percent within 30 minutes. Baldwin *et. al.* (2003) identified a Cu concentration neurotoxic threshold of an increase of 2.3 to 3.0 μg/L, when background levels are 3.0 μg/L or less. When exceeded, this threshold is associated with olfactory inhibition. The authors also reference three other studies examining long-duration Cu exposures (i.e., exceeding 4 hours); these studies found that long-duration exposures resulted in cell (olfactory receptor neuron) death in rainbow trout and Atlantic and Chinook salmon. Baldwin *et. al.* (2003) found that water hardness did not influence the toxicity of Cu to coho salmon sensory neurons.

The effects of short-term Cu exposure may persist for hours and possibly longer. Although salmonids may actively avoid surface waters containing an excess of dissolved Cu, those individuals that are exposed may experience olfactory function inhibition within minutes of exposure. Furthermore, avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This, in turn, can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

Folmar (1976) observed avoidance responses in rainbow trout fry when exposed to a Lowest Observed Effect Concentration of 0.1 μg/L dissolved Cu (hardness of 90 mg/L). The EPA (1980) also documented avoidance by rainbow trout fry of dissolved Cu concentrations as low as 0.1 μg/L during a 1 hour exposure, as well as a LC10 for smolts exposed to 7.0 μg/L for 200 hours, and a LC10 for juveniles exposed to 9.0 μg/L for 200 hours.

Zinc (Zn)

While Zn occurs naturally in the environment and is an essential trace element for most organisms, in sufficient concentrations and when bioavailable for uptake by aquatic organisms, excess Zn is toxic. Toxicity in the aquatic environment and for exposed aquatic organisms is influenced by water hardness, pH, organic matter content, levels of dissolved oxygen, phosphate, and suspended solids, the presence of mixtures (i.e., synergistic effects), trophic level, and exposure frequency and duration (Eisler 1993). Bio-availability of zinc is increased under conditions of high dissolved oxygen, low salinity, low pH, and/or high levels of inorganic oxides and humic substances. Most of the Zn introduced into aquatic environments is eventually partitioned into sediments (Eisler 1993).

Effects of Zn exposure include 1) weakened immune function and impaired disease resistance (Ghanmi *et. al.* 1989), 2) impaired respiration, including potentially lethal destruction of gill epithelium (Eisler 1993), 3) altered blood and serum chemistry, and enzyme activity and function (Hilmy *et. al.* 1987a; Hilmy *et. al.*1987b), 4) interference with gall bladder and gill metabolism (Eisler 1993), 5) hyperglycemia, and 6) jaw and branchial abnormalities (Eisler 1993).

Hansen *et. al.* (2002) determined 120-day lethal concentrations of Zn for test subjects that included bull trout and rainbow trout fry. Multiple pairs of tests were performed with a nominal pH of 7.5, hardness of 30 mg/L, and at a temperature of 8 °C. Bull trout LC50 values measured under these conditions ranged from 35.6 to 80.0 μg/L, with an average of 56.1 μg/L. Hansen *et. al.* (2002) found that rainbow trout fry are more sensitive to Zn (i.e., exhibit a lower LC50) than are bull trout fry. The authors also report that older, more active juvenile bull trout are more sensitive than younger, more docile juvenile bull trout based on observed changes in behavior at the juvenile life stage. The authors argue that the timing of Zn (and cadmium) exposure and the activity level of the exposed fish are germane to predicting toxicity in the field.

The mode of action for Zn toxicity relates to net loss of calcium. Studies suggest that Zn exposure inhibits calcium uptake, although it appears this effect is reversible once fish return to clean water. The apparent difference in sensitivity between rainbow trout and bull trout may be due to the lesser susceptibility of bull trout to calcium loss. Hansen *et. al.* (2002) state that differences in sensitivity between these two salmonids may reflect different physiological strategies for regulating calcium uptake. These strategies may include gills that differ structurally, differences in the mechanisms for calcium uptake, and/or variation in resistance to or tolerance for calcium loss.

There are no known studies or data describing adult bull trout response to lethal (or near-lethal) concentrations of Zn. Active feeding and increased metabolic activity are apparently related to sensitivity. It is unknown whether sensitivity to Zn varies between adult, subadult, and juvenile bull trout. Activity level may be a better predictor of sensitivity than age.

In addition to the physiological effects of Zn exposure, studies have also documented a variety of biobehavioral responses. Among these, Eisler (1993) includes altered avoidance behavior, decreased swimming ability, and hyperactivity. The author also suggests Zn exposure has implications for growth, reproduction, and survival.

Sublethal endpoints have been evaluated with test subjects that include both juvenile and adult rainbow trout (Eisler 1993; EPA 1980; EPA 1987; Spear 1981). Some of these test results clearly indicate that juvenile rainbow trout are more sensitive than adult rainbow trout. Using juvenile rainbow trout as test subjects, studies have found that sublethal effects occur at concentrations approximately 75 percent lower (5.6 μg/L) than the concentrations that result in lethal effects (24 μg/L) (Eisler 1993; Hansen *et. al.* 2002). Sprague (1968) found that at concentrations as low as 5.6 μg/L juvenile rainbow trout exhibit avoidance behavior.

Although salmonids may actively avoid surface waters containing an excess of dissolved Zn, it can generally be assumed that highway runoff contains a mixture of pollutants, including some known to affect the olfactory system (i.e., dissolved Cu). Due to exposure to these mixtures, bull trout may not always be capable of detecting and avoiding elevated levels of dissolved Zn. Furthermore, avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This, in turn, can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

Stormwater Pollutant Exposure and Effects Analysis

Bull trout may be exposed to increases in stormwater pollutants originating from TDAs 1-3. In particular, increases in post-project annual loadings of dissolved Zn, total and dissolved Cu, coupled with reduced (but still elevated) effluent/discharge metal concentrations, are likely to adversely affect bull trout.

Post-project treated effluent concentrations are expected to be 40 μg/L total Zn, 27 μg/L dissolved Zn, 7 μg/L total Cu, and 5 μg/L dissolved Cu at the points of discharge (FHWA 2006). Expected post-project dissolved Zn concentrations (approximately 27 μg/L at discharge) are reduced compared to pre-project concentrations (approximately 62 μg/L at discharge), but still greatly exceed concentrations known to elicit avoidance behavior (Sprague 1968), and approach concentrations that may be lethal to bull trout fry (Hansen *et. al.* 2002). Similarly, expected post-project dissolved Cu concentrations (approximately 5 μg/L at discharge) are reduced compared to pre-project concentrations (approximately 7.6 μg/L at discharge), but still exceed the sublethal neurotoxic threshold of an increase of 2.3 to 3.0 μg/L over background (Baldwin *et. al.* 2003). Both Eisler (1998) and Playle (2004) found that dissolved metal mixtures exhibit greater than additive toxicity (i.e., synergistic effects), so there is ample reason to conclude treated stormwater discharges originating from TDAs 1-3 could result in adverse effects to exposed fish.

The Skykomish River side-channel and the two, unnamed minor tributaries which extend north and east across the floodplain provide suitable habitat for bull trout. Owing to its size and functional value as off-channel habitat, the Skykomish River side-channel may support bull trout almost any time of year. However, since during periods of low-flow the side-channel is poorly connected to the main channel and offers fewer pools of significant depth, bull trout are more likely to use the side-channel outside of the low-flow summer months. Similarly, the two, unnamed minor tributaries probably function most importantly as off-channel habitat outside of the low-flow summer months. Subadult and adult bull trout are expected to use lower portions of these minor tributaries as refuge from high flows in the mainstem Snohomish and Skykomish Rivers. Post-project, and for the functional life of the project (in perpetuity), these same waterbodies will receive treated stormwater runoff originating from TDAs 1-3.

The following scenarios are expected to present a risk of exposure (ordered highest-to-lowest): 1) Wet-weather discharges directly to the Skykomish River side-channel (TDAs 1); 2) Wet-weather discharges to the two, unnamed minor tributaries which extend north and east across the floodplain (TDAs 2 and 3); and 3) Low-flow (summer month) discharges to the Skykomish River side-channel (TDA 1).

During the summer months surface water temperatures along the minor tributaries are likely elevated and, therefore, the Service does not expect bull trout would be exposed to stormwater discharges originating from TDAs 2 and 3. However, low-flow (summer month) discharges directly to the Skykomish River side-channel (i.e., from TDA 1) may expose bull trout and would occur at a time when the receiving waterbody is least capable of mixing and diluting stormwater discharge.

Wet-weather stormwater discharges will be more frequent, of longer duration, and greater in magnitude compared to low-flow (summer month) discharges. Wet-weather stormwater discharges pose a risk of exposure along both the minor tributaries and within the Skykomish River side-channel, which ultimately receives all drainage from TDAs 1-3. While more frequent, of longer duration, and greater in magnitude compared to low-flow (summer month) discharges, wet-weather stormwater discharges would occur at a time when the receiving waterbodies are best capable of mixing and diluting stormwater discharge.

Stormwater from TDAs 2 and 3 will discharge to a series of remnant oxbows, beaver ponds, and inundated wetlands before reaching the lower portions of tributaries where bull trout are most likely to occur. While the WSDOT and FHWA have not modeled dilution along these waterbodies, the BA estimates post-project discharge volume and streamflow across a range of storm events (e.g., 6-month, 2-year, 10-year, etc.) (FHWA 2006). Using these estimates and applying the expected post-project treated effluent concentrations summarized above, dissolved Zn and Cu concentrations are expected to dilute to levels that do not result in sublethal effects before reaching habitats where bull trout might be exposed. While there is not sufficient information to quantitatively describe the downstream extent of the "mixing zone" for these TDAs and outfalls, effects to bull trout associated with both low-flow and wet-weather stormwater discharges from TDAs 2 and 3 are not expected to measurably effect bull trout behavior and are therefore insignificant.

Both low-flow (summer month) and wet-weather stormwater discharges to the Skykomish River side-channel pose a risk of exposing bull trout to increases in stormwater pollutants. At completion, the project will direct discharge treated runoff from approximately 22 acres of PGIS in TDAs 1 and 2, through new outfalls along the side-channel (near Bridge 522/138) and along minor tributary "07-0814(d)" approximately 5,000 ft upstream of the side-channel.

During summer months, discharges from TDAs 1 and 2 are expected to be infrequent and of short duration. However, these discharges are more likely to contain elevated pollutant concentrations (as the result of a "first-flush") and would occur when the receiving waterbody is least capable of mixing and diluting stormwater discharge. Wet-weather stormwater discharges from TDAs 1 and 2 would occur when the side-channel is generally activated (i.e., carrying increased flows), and when the receiving waterbody is best capable of mixing and diluting stormwater, but also at times of year when bull trout are more likely to be present and occupying habitats along the side-channel.

The Skykomish River side-channel is dynamic and because of the predominantly fine substrate condition and frequent high-flow events, channel geometry is unstable. Combined with significant day-to-day and seasonal variation in flow, conditions along the side-channel make it very difficult to reliably predict or describe mixing and rates of dilution (WSDOT 2007c). However, the WSDOT and FHWA have provided information to describe a potential worst-case scenario; prolonged and heavy local precipitation coinciding with a low-flow condition along the side-channel. Under this scenario, treated stormwater discharges originating from TDA 1 and discharged at the new outfall positioned in the immediate vicinity of Bridge 522/138, could travel as far as the confluence with the mainstem Snohomish River (approximately 500 ft) before sufficiently mixing and diluting such that concentrations of dissolved Zn and Cu fall below levels that result in adverse sublethal effects.

The Service expects that juvenile, subadult, and adult bull trout will be exposed to stormwater pollutants at concentrations that may have adverse sublethal effects. These exposures will be episodic, occurring whenever bull trout are present near the outfall from TDA 1 coincident with discharge from storm events. The size of the "mixing zone" is expected to vary based on flow and discharge conditions, but may under the worst-case scenario extend as far as 500 ft downstream. Exposure durations may be longer and more frequent during wet-weather, but the physical extent of the "mixing zone" should be reduced when the side-channel is carrying increased flows.

Juvenile, subadult, and adult bull trout are expected to be exposed to concentrations of dissolved metals sufficient to result in adverse sublethal effects, including avoidance response and reduced olfactory sensory responsiveness. These exposures are expected to disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter). Bull trout may avoid the vicinity of the outfall from TDA 1, and the confluence of the Skykomish River side-channel and mainstem Snohomish River, when stormwater discharges are sufficient to result in elevated pollutant concentrations. This avoidance behavior may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. Bull trout exposed at sufficient concentrations, and for sufficient durations, may experience olfactory inhibition. These effects may in turn impair free movement through the action area, foraging success and feeding efficiency, and may cause exposed fish to be more vulnerable to predation. Because suitable spawning habitats are not present in the action area, exposure to increases in stormwater pollutants is not expected to interfere with bull trout reproductive behaviors.

The Service expects that sublethal effects to individual bull trout will be episodic and of limited duration. Some bull trout may be exposed repeatedly as a result of regular, seasonal movements through the action area. However, few, if any, bull trout are expected within the side-channel at a frequency and duration that would make chronic exposures a concern.

Summary of Effects (Matrix of Pathways and Indicators)

An earlier section applied the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998) as a tool for describing whether habitat is functioning adequately, functioning at risk, or functioning at unacceptable levels of risk at the scale of the action area (Environmental Baseline, Existing Conditions in the Action Area). Table 7 summarizes the effects of the action using this same matrix. For a fuller description of the anticipated effects of the action see the preceding sections.

Table 7. Effects of the action ("Matrix of Pathways & Indicators").

Pathway	Indicator	Baseline Conditions	Effect of the Action
Water Quality	Temperature	At Risk	Maintain
	Sediment	At Risk	**Degrade**
	Chemical Contamination & Nutrients	At Risk	**Degrade**
Habitat Access	Physical Barriers	Unacceptable Risk	**Restore**
Habitat Elements	Substrate	At Risk	Maintain
	Large Woody Debris	Unacceptable Risk	Maintain
	Pool Frequency / Quality	At Risk	Maintain
	Large Pools	At Risk	Maintain
	Off-Channel Habitat	At Risk	**Degrade**
	Refugia	At Risk	**Degrade**
Channel Conditions & Dynamics	Width/Depth Ratio	At Risk	Maintain
	Streambank Condition	At Risk	Maintain
	Floodplain Connectivity	At Risk	Maintain
Flow / Hydrology	Peak / Base Flows	At Risk	Maintain
	Drainage Network	At Risk	Maintain
Watershed Conditions	Road Density / Location	Unacceptable Risk	**Degrade**
	Disturbance History	At Risk	Maintain
	Riparian Reserve	At Risk	Maintain

Effects to the PCEs of Designated Bull Trout Critical Habitat

An earlier section identified the PCEs that define bull trout critical habitat and described their baseline condition in the action area ("Environmental Baseline", Status of Critical Habitat in the Action Area). The following section discusses the effects of the action with reference to seven of the eight PCEs. Designated critical habitat present within the action area does not include PCE #3 (i.e., *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival*).

The proposed action will have both temporary and permanent adverse effects to designated bull trout critical habitat. Work conducted within or directly over the mainstem Snohomish River, including placement of temporary piles and use of a large over-water work trestle for the duration of two in-water construction seasons, will have measurable effects on the condition and function of the migratory corridor and on water quality. The proposed action will have adverse effects to bull trout critical habitat associated with long-term (operational) stormwater effects to surface water quality.

PCE #1 (*Water Temperatures*) – The waters within the action area are *functioning at risk* for the temperature indicator. Daily maximum temperatures in excess of 15 °C are commonplace during summer months and short duration extremes of temperature, in excess of 20 °C, have been documented in the action area and further upstream (WDOE 2007). However, the designated critical habitat within the action area provides large, deep pools where bull trout can seek refuge from seasonally high surface water temperatures at any time of year. The proposed project will replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to approved ratios, prior to or concurrent with construction of the larger project. The proposed action would create approximately 27.6 acres of new PGIS, an approximately 85 percent increase to the amount of PGIS already along the project corridor, but also includes a stormwater design using enhanced treatment BMPs that allow passive infiltration (i.e., combined detention/stormwater treatment wetlands). Because in TDAs 1 and 2 the project will seek flow control exemptions and direct discharge rather than detain large volumes of treated stormwater, and because the large facilities proposed in TDAs 3-6 can be expected to fully infiltrate runoff from most storm events and will discharge to the receiving waterbody on an infrequent basis (i.e., events exceeding the 6-month storm event), stormwater discharges originating from the project are not expected to cause or contribute to measurable increases in surface water temperature within the action area. As such, effects to PCE #1 will be insignificant.

PCE #2 (*Complex Stream Channels*) – The designated critical habitat within the action area provides deep pools, thermal refugia, point bars, side-channels, and other forms of channel complexity across a range of flows. The proposed action will not cause or contribute to a simplification of these instream habitats. However, the proposed action is expected to have adverse long-term (operational) stormwater effects to surface water quality, including effects which may diminish function of the Skykomish River side-channel in the immediate vicinity of Bridge 522/138. These effects to surface water quality and function of the Skykomish River side-channel will be episodic, but will persist in perpetuity for the life of the project. For a fuller discussion of these effects see preceding sub-sections (Operational Effects to Surface Water

Quality and Instream Habitat; Stormwater Pollutant Exposure and Effects Analysis). The proposed action will have an adverse effect on PCE #2.

PCE #4 (*Natural Hydrograph*) – The proposed action will not have a measurable effect on the size or frequency of peak, high, low or base flows, on day-to-day or seasonal fluctuations of the natural hydrograph along these portions of the Snohomish, Snoqualmie, and Skykomish Rivers. As such, effects to PCE #4 will be insignificant.

PCE #5 (*Sources of Cold Water*) – The proposed action will influence patterns of runoff, infiltration, and subsurface water exchange on a local scale, but will have no measurable effect on sources of cold water (e.g., springs or seeps) contributing to these portions of the Snohomish, Snoqualmie, and Skykomish Rivers. The proposed stormwater design is not expected to cause or contribute to measurable increases in surface water temperature, and will not degrade thermal refugia within the action area. As such, effects to PCE #5 will be insignificant.

PCE #6 (*Migratory Corridors With Minimal Impediments*) – The proposed action will have both temporary and permanent adverse effects to the condition and function of the migratory corridor. Work conducted within or directly over the mainstem Snohomish River, including placement of temporary piles and use of a large over-water work trestle for two in-water construction seasons, is expected to have measurable temporary effects on the condition and function of the migratory corridor. For a fuller discussion of these effects see preceding sub-sections (Exposure to Elevated In-Water Sound Pressure Levels; Exposure to Elevated Turbidity and Sedimentation During Construction). In addition, the proposed action will adversely affect bull trout critical habitat as a result of long-term (operational) stormwater effects to surface water quality. These effects to surface water quality will be episodic, but will persist in perpetuity for the life of the project. For a fuller discussion of these effects see preceding sub-sections (Operational Effects to Surface Water Quality and Instream Habitat; Stormwater Pollutant Exposure and Effects Analysis). The proposed action will have an adverse effect on PCE #6.

PCE #7 (*Food Base*) – The Snohomish, Snoqualmie, and Skykomish Rivers and their tributaries support populations of chum, coho, Chinook, pink and steelhead salmon, in addition to resident and sea-run cutthroat trout; these populations provide an ample prey base for adult and subadult bull trout. The proposed action is not expected to measurably diminish the productivity or availability of bull trout prey in either the short- or long-term. As such, effects to PCE #7 will be insignificant.

PCE #8 (*Water Quantity and Quality*) – The proposed action will have both temporary and permanent adverse effects to water quality. Work conducted within or directly over the mainstem Snohomish River will have measurable temporary effects on water quality. For a fuller discussion of these effects see a preceding sub-section (Exposure to Elevated Turbidity and Sedimentation During Construction). In addition, the proposed action will adversely affect bull trout critical habitat as a result of long-term (operational) stormwater effects to surface water quality. These effects to surface water quality will be episodic, but will persist in perpetuity for the life of the project. For a fuller discussion of these effects see preceding sub-sections

(Operational Effects to Surface Water Quality and Instream Habitat; Stormwater Pollutant Exposure and Effects Analysis). The proposed action will have an adverse effect on PCE #8.

Effects of Interrelated & Interdependent Actions

Interrelated actions are defined as actions "that are part of a larger action and depend on the larger action for their justification"; interdependent actions are defined as actions "that have no independent utility apart from the action under consideration" (50 CFR section 402.02). The following may be considered interrelated or interdependent actions related to the proposed action under consideration:

- On-site and off-site compensatory mitigation to replace lost and/or degraded wetland/buffer, floodplain, and riparian functions and values according to approved ratios.

- Construction and maintenance of an approximately 0.8 acre temporary haul road(s) for the purpose of gaining access to the Snohomish-Skykomish floodplain where bridge pier columns and footings will be constructed.

At the time of this BO's preparation, the WSDOT and FHWA expect that compensatory mitigation will be a combination of on-site and off-site enhancement and restoration activities. Most of the project's unavoidable impacts to wetland/buffer, floodplain, and riparian functions will be mitigated off-site. The WSDOT has identified what it believes are the top-two candidate "in-basin" and watershed opportunities, both of which are privately owned, permitted, and developed mitigation banks located within basin (MacDonald pers. comm. 2007):

- Skykomish Habitat Mitigation Bank (Skykomish Habitat, LLC), located at 18016 177th Ave. SE, Monroe, Washington 98272; and,

- Snohomish Basin Mitigation Bank (Habitat Bank, LLC), located at 24219 High Bridge Rd., Monroe, Washington 98272.

These facilities are either constructed, or are partially constructed, and nearly ready to begin offering credits. The issuance of credits will follow the processes detailed in each bank's mitigation bank instrument, which were approved by both WDOE and USACE. Both of these were the subject of earlier informal consultations with the Service (Skykomish Habitat, LLC – FWS Reference Number 1-3-05-I-0426; and Habitat Bank, LLC – FWS Reference Number 1-3-05-I-0276).

Previous sub-sections of this BO, and the two informal consultations identified above, have addressed all of the foreseeable direct and indirect effects that may result from these interrelated and interdependent actions. No additional effects to bull trout or bull trout critical habitat are expected to result from interrelated or interdependent actions.

Indirect Effects

The terrestrial and aquatic boundaries of the action area are defined with consideration for both temporary, construction-related effects on the environment and potential indirect effects that may occur later in time as a result of the proposed action. Indirect effects are those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur. The action's potential indirect effects include both those associated with long-term (operational) stormwater discharges and those associated with land use changes expected to result, in whole or in part, from the proposed action.

The adverse effects to bull trout and designated bull trout critical habitat expected to result from long-term (operational) discharge of treated highway stormwater runoff were described in preceding sub-sections (Operational Effects to Surface Water Quality and Instream Habitat; Effects to the PCEs of Designated Bull Trout Critical Habitat). The following sub-section assesses potential land use changes which may result from the proposed action, and whether and how these changes may result in additional effects to bull trout or their designated critical habitat.

Land Use Changes and Related Effects to the Environment

The proposed project is one of the last phases (or the last) among a series of projects designed to improve SR 522 by expanding capacity. The project will widen approximately four miles of SR 522 from two lanes to four lanes and will improve two interchanges. The project is designed to accommodate a significant projected future increase in travel demand, from a current ADT of 18,000-19,000 vehicles per day (2001-2003) to an estimated ADT of 53,000 vehicles per day in the design year (2030).

It is difficult to describe with certainty where land use changes may result, in whole or in part, from the proposed project. The submitted BA does not assess changes in the rate or pattern of land use conversion, development of vacant or under-developed parcels, or conversion of agricultural or rural residential land to more intensive land uses. When defining the spatial extent of the action area, the BA relies instead only on construction-related increases in sound and visual disturbance, and temporary effects to water quality.

In order to determine the full extent of the action area, and to assess where potential land use changes may result from the proposed action, the Service considered existing patterns of land use and zoning, long-term community planning and economic development objectives, and concurrency and other growth management policies and requirements. Sources of information included various planning documents prepared by (or for) Snohomish County and the City of Monroe, and personal communications with staff from the Snohomish County Public Works Department and City of Monroe. This BO defines the terrestrial and aquatic boundaries of the action area so as to encompass all areas where the Service expects land use changes may result, in whole or in part, from the proposed project. Along eastern portions of the project corridor, the City of Monroe's current UGA boundary has been used to define the spatial extent of the action area.

Where sources of information suggest land use changes may result, in whole or in part, from the proposed action, the Service evaluated the potential for land use conversion, development of vacant or under-developed parcels, and conversion of agricultural or rural residential land to more intensive land uses. In turn, the Service considered the potential land use changes and how and where they may result in effects to the environment with significance for bull trout and designated bull trout critical habitat.

The proposed action will not establish new access to any area along the project corridor and no plans for development are contingent or fully dependent upon the proposed highway and interchange improvements (FHWA 2006). No building moratoriums are in effect and it appears that there are no permit applications (or pending permits) conditioned upon completion of the project (Bloodgood, Snohomish County Public Works, pers. comm. 2006; Gathmann, City of Monroe, pers. comm. 2006 *in* FHWA 2006). Any newly developed or redeveloped areas will be subject to State and County environmental permit requirements, including those requirements established for the protection of wetlands and floodplain and for the regulation of private and municipal stormwater discharges.

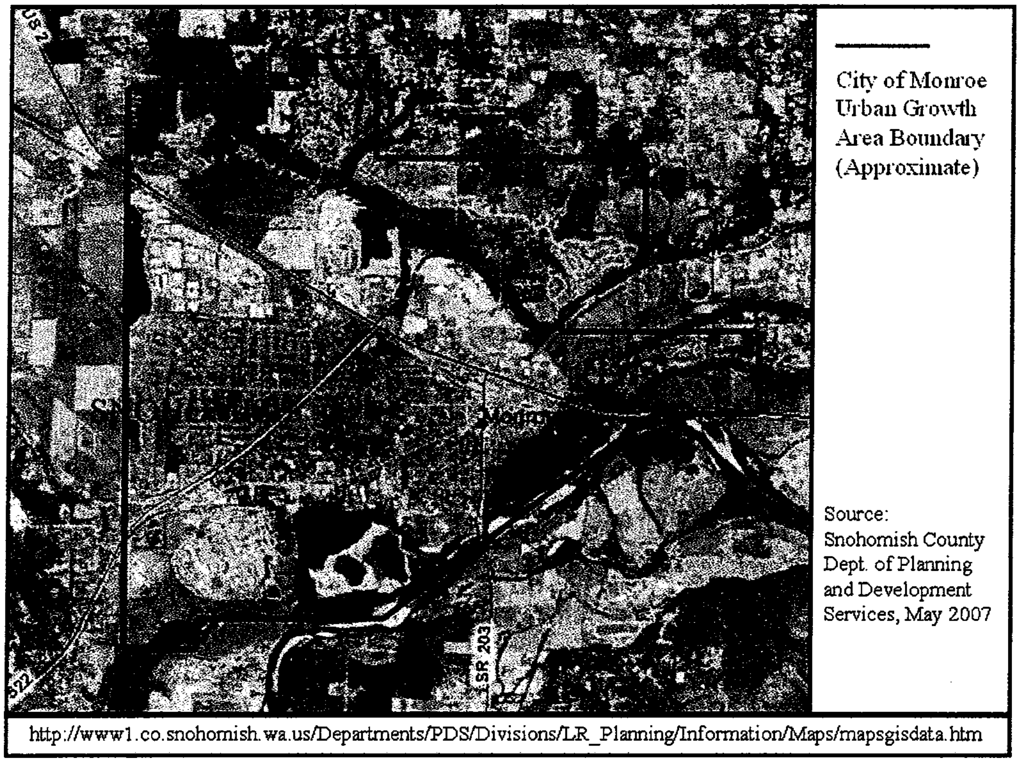
Along much of the project corridor, from the Snohomish River crossing east to the vicinity of the 164th Street SE/Tester Road surface arterial interchange, SR 522 is a limited-access controlled facility. Along this portion of the corridor land use and zoning are as follows (FHWA 2006; Snohomish County 2007a): rural residential, rural conservation/open space, agricultural, commercial, parks, and mineral conservation; agricultural 10-acre, rural 5-acre, city (City of Monroe), rural conservation, forestry, and parks.

The proposed action will not create new points of access between the Snohomish River crossing and 164th Street SE/Tester Road interchange. According to land use plans for Snohomish County and the City of Monroe, future development and growth will be promoted in areas already characterized by urban development, where existing and planned services are adequate, and will both recognize and preserve rural land uses and the "rural character" of surrounding areas (FHWA 2006; Snohomish County 2007b).

Along and adjacent to the western portion of the project corridor, the proposed action is not expected to result in land use conversion, development of vacant or under-developed parcels, or conversion of agricultural or rural residential land to more intensive land uses. Since no land use conversion or development is anticipated, the Service does not expect related effects to the environment. The proposed action will not cause indirect effects to native vegetation, the relative amount of pervious and impervious surface, wetland and floodplain function, or water quality and quantity, in these portions of the action area.

Eastern portions of the project corridor, from the 164th Street SE/Tester Road surface arterial interchange to the reconstructed SR 522 / US 2 interchange, are located entirely within incorporated city limits (City of Monroe). Here, the proposed project is important to long-term planning objectives and can be expected to facilitate growth within the City of Monroe and its UGA (FHWA 2006; Snohomish County 2007b). The Service expects the proposed action may promote and encourage land use conversion and re-development along the eastern portion of the project corridor and within the City of Monroe UGA (Figure 7).

Figure 7. City of Monroe UGA.



Much of the area along the project corridor and within the City of Monroe UGA is zoned urban residential, multi-family residential, and general commercial (City of Monroe 2007a). Current land uses are already predominantly residential and commercial. The Monroe High School and Monroe Correctional Facility occupy large tracts of land (zoned public open space) adjacent to the 164th Street SE/Tester Road interchange.

The proposed action will improve two interchanges within the City of Monroe UGA and is designed to accommodate a significant projected future increase in travel demand (FHWA 2006). These improvements will relieve congestion and improve mobility. The Service expects these improvements will thereby support and promote the City of Monroe's plans for redevelopment of the downtown commercial core and residential sub-divisions. This redevelopment may include conversion of single-family housing to commercial and professional/office uses, infilling of higher-density residential developments, and improvements to some of the City's other amenities and facilities (e.g., commercial parking, streetscape, bicycle/pedestrian/multi-use trails and pathways, etc.) (City of Monroe 2005). However, because of concurrency requirements, some of this redevelopment will require other improvements to the City's essential services, including local road improvements not included in the proposed action under consultation (City of Monroe 2005).

The proposed action is expected to promote redevelopment within the UGA and therefore may result in indirect effects to native vegetation, the relative amount of pervious and impervious surface, wetland and floodplain function, and water quality and quantity, through these eastern portions of the action area. While the City of Monroe UGA includes a small portion of the lower Skykomish River floodplain, most of the UGA drains to two minor tributaries to Cripple Creek (French Creek basin).

According to the City of Monroe's Comprehensive Plan (City of Monroe 2005), the UGA contains approximately 123 acres of vacant residential land capacity and approximately 163 acres of vacant commercial-industrial land capacity. While this information is useful for describing the total amount of vacant or under-developed land within the UGA, it is not possible with available information to describe with certainty what portion of this land may be developed or redeveloped, in whole or in part, because of the proposed action.

The City of Monroe and Snohomish County Comprehensive Plans, Shoreline Management Programs, and Critical Area Ordinances provide a framework for identifying and protecting valued landscape features and ecological functions. The Service expects this framework is not entirely protective, but will nevertheless serve to avoid and/or reduce effects to ecological functions as additional portions of the UGA develop (or redevelop).

A portion of the lower Skykomish River floodplain, and associated wetlands and waterbodies, lie within the City of Monroe UGA. The condition, health, and function of these landscape features are particularly important to bull trout and to designated bull trout critical habitat found within the action area. Effective November 4, 2007, the City of Monroe adopted a revised Shoreline Management Master Program providing for the management and protection of shoreline resources, and the planning of their reasonable and appropriate uses, consistent with WDOE's most current shoreline management guidelines (City of Monroe 2007b). The Skykomish River is a shoreline of statewide significance and the City of Monroe used its discretion to designate as regulated shoreline the full extent of the 100-year floodplain, including all wetlands located within the floodplain and others outside but "associated" with the floodplain. All new development and uses, including proposals for redevelopment, must comply with the policies and regulations established by the Shoreline Management Act (Revised Code of Washington 90.58) and the City of Monroe's Shoreline Management Master Program (City of Monroe 2007b).

The Service expects the proposed action's indirect effects to native vegetation, the relative amount of pervious and impervious surface, wetland function, and water quality and quantity, are most likely to occur within those portions of the UGA that drain to Cripple Creek (French Creek basin). Due in part to its degraded baseline condition, Cripple Creek and the upper French Creek subbasin do not provide suitable habitat for bull trout and do not support bull trout at any time of year. Therefore, it is extremely unlikely bull trout will be exposed to these indirect effects to watershed functions, surface water quality, and instream habitat. Any indirect effects that occur within portions of the UGA that drain to the Skykomish River will be limited in extent and will not have a measurable effect on bull trout or designated bull trout critical habitat. The Service expects that land use changes resulting, in whole or in part, from the proposed action will not have measurable adverse effects on bull trout or designated bull trout critical habitat.

Effects at the Local Population, Core Area, and Recovery Unit Scales

The proposed action will adversely affect foraging and migrating adult, subadult, and juvenile bull trout and the PCEs of designated bull trout critical habitat. The effects can be grouped into two categories: temporary effects during construction (e.g., exposure to elevated underwater sound pressure levels and turbidity); and permanent or long-term effects associated with operation (e.g., effects to surface water quality and instream habitat resulting from stormwater discharge). The proposed action does incorporate both permanent design elements and conservation measures which will reduce effects to habitat and avoid and minimize impacts during construction.

The Service considers the waters within the action area to be FMO habitat for bull trout. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas (USFWS 2004b). Many bull trout of the Snohomish-Skykomish core area are anadromous and therefore rely on middle portions of the Snohomish basin for migrating, overwintering, extended rearing, and growth to maturity (USFWS 2004b). The major rivers within the action area provide important FMO habitat for all anadromous bull trout of the Snohomish-Skykomish core area. Adult, subadult, and juvenile bull trout may occupy these waters at any time of year, but information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

The action's temporary adverse effects will be of limited extent and duration, only persisting for the 250-day period when in-water and over-water construction activities are being completed. With full implementation of the proposed conservation measures, the Service expects that only low numbers of adult, subadult, and juvenile bull trout will be exposed to construction activities and may be adversely affected.

Individual bull trout may be killed or injured as a result of exposure to temporarily elevated underwater SPLs. With full implementation of the proposed conservation measures, only low numbers of bull trout may suffer these effects. Exposure to elevated underwater SPLs and turbidity may also disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter), potentially resulting in reduced growth, reproductive fitness (fecundity), and survival for a larger, but still small, number of affected bull trout.

The action's permanent adverse effects will last in perpetuity (for the life of the project), but will be of limited extent and episodic. Adult, subadult, and juvenile bull trout occupying habitats in close proximity to the outfall from TDA 1 (and confluence of the Skykomish River side-channel and mainstem Snohomish River) will be exposed to elevated stormwater pollutant concentrations sufficient to disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter). Exposure and the resulting sublethal effects will be episodic, occurring only or principally when stormwater discharges coincide with a low-flow condition (i.e., when the receiving waterbody is least capable of mixing and thereby diluting stormwater discharge).

These permanent or long-term effects present a greater risk to bull trout. A comparatively larger number of bull trout will or may be exposed to these permanent effects, and some individuals may be exposed repeatedly over time. The action's permanent adverse effects may diminish function, including function as a migratory corridor, along a portion of the Skykomish River side-channel in the immediate vicinity of Bridge 522/138. The action's permanent adverse effects include effects to the PCEs of designated bull trout critical habitat (PCE #s 2, 6, and 8).

To comprehensively evaluate the effects of the action, the Service must consider exposure and effects to individual fish, effects to habitat and habitat functions, and the accumulated response of populations of exposed fish over time (USFWS and NMFS 1998). Each core area is vital to maintaining the overall distribution and genetic diversity of bull trout within the Puget Sound Management Unit (USFWS 2004b), and the Snohomish-Skykomish core area therefore plays a critical role in the rangewide conservation and recovery of bull trout.

The status of a core area is based on four elements: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004b). Preceding sections have discussed the current status of the Snohomish-Skykomish core area. The core area's four local populations exhibit stable, but low numbers despite a number of threats and reasons for decline. Connectivity between three of the four local populations (all except the Troublesome Creek population) diminishes the risk of extirpation in the core area (USFWS 2004b). The anadromous life history form is well represented.

Bull trout may be killed or injured as a result of exposure to elevated underwater SPLs and therefore the proposed action may temporarily reduce the total number of individual bull trout within the Snohomish-Skykomish core area. However, this effect will be of limited extent and duration, and only low numbers of adult, subadult, and juvenile bull trout will or may be affected in this manner. Exposure to elevated underwater SPLs and turbidity during construction will also disrupt normal bull trout behaviors (feeding, moving, and sheltering). Individual bull trout may experience reduced growth, reproductive fitness (fecundity), and survival as a result of these exposures. A larger number of adult, subadult, and juvenile bull trout may be affected (i.e., compared to those killed or injured by elevated SPLs), but the effects will be of limited extent and duration, and still only low numbers of bull trout will or may be affected in this manner.

In both cases, fish exposed to the action's temporary construction-related effects are likely to originate from more than one of the core area's four local populations. These populations exhibit stable numbers and some degree of resiliency to ongoing threats and reasons for decline. Therefore, the Service does not expect that this temporary reduction in numbers (abundance) or these effects to reproduction (productivity) will measurably reduce the likelihood of persistence at the local population or Snohomish-Skykomish core area scales. We do not expect that resulting effects to reproduction (productivity) will be measurable at the scale of the local populations or Snohomish-Skykomish core area.

The action will have permanent adverse effects to surface water quality and instream habitat. Given the action area's prominent location along a mainstem migratory channel, it is possible that over the long-term a large proportion of the anadromous bull trout of the Snohomish-Skykomish core area may be exposed to these effects. Furthermore, some individuals may be exposed repeatedly, and may thereby experience greater or more intense sublethal effects to growth, reproductive fitness (fecundity), and survival.

When the accumulated response of exposed fish is considered over time, it is possible to conclude the proposed action might have measurable effects to numbers (abundance) and reproduction (productivity). However, several factors suggest these effects will not be measurable at the scale of the Snohomish-Skykomish core area:

- *Proximity of the Effect* - Suitable spawning and early rearing habitats are not present within the action area. The proposed action will not affect habitat supporting essential spawning and early rearing behaviors.

- *Nature and Intensity of the Effect* - The action's permanent adverse effects to surface water quality and instream habitat will be of limited extent, extending approximately 500 ft from the point of discharge (stormwater outfall from TDA 1), as far as the confluence with the mainstem Snohomish River. Only bull trout in close proximity to the outfall from TDA 1 will be exposed and may suffer adverse effects. Most exposures will be of short duration and therefore of low or moderate intensity. Exposures resulting in lethal effects are not expected.

- *Timing, Frequency, and Duration of the Effect* - The action's permanent adverse effects to surface water quality and instream habitat will be episodic, exposing only those bull trout in close proximity to the outfall from TDA 1 when stormwater discharges coincide with a low-flow condition. In this respect, while the function of the Skykomish River side-channel and migratory corridor may at times be impaired, at other times (and in fact most of the time) effects to surface water quality and habitat function will not be measurable and will be of little or no significance to foraging and migrating bull trout. Many bull trout using the action area will not be exposed to adverse effects.

Affected bull trout are likely to originate from more than one of the core area's four local populations and considering the accumulated response of exposed fish over time, the several additional factors summarized above, and the current status of the core area, the Service does not expect that the action's long-term effects to numbers (abundance) or reproduction (productivity) will measurably reduce the likelihood of persistence at the local population or Snohomish-Skykomish core area scales. We do not expect that effects to numbers (abundance) or reproduction (productivity) will be measurable at the scale of the Snohomish-Skykomish core area.

Taken as a whole, the direct and indirect effects of the proposed action, including all temporary and permanent adverse effects, will not measurably reduce the likelihood of persistence at the local population or Snohomish-Skykomish core area scales. While the function of the Skykomish River side-channel and migratory corridor may at times be impaired, effects to connectivity will be insignificant at the scale of the core area and interim recovery unit (Puget Sound Management Unit). While bull trout exhibiting an anadromous life history are more likely to be exposed to the action's adverse effects, the Service does not expect that the proposed action will have a measurable effect on the relative size of the anadromous component contributing to the core area's local populations. The Service does not expect that the action's effects to numbers (abundance), reproduction (productivity), or distribution will be measurable at the scale of the Snohomish-Skykomish core area or interim recovery unit.

CUMULATIVE EFFECTS (Bull Trout and Designated Critical Habitat)

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

State actions which may affect Snohomish-Skykomish bull trout and designated critical habitat within the action area include continued implementation of the Forest Practices Act and planning and implementation of various TMDL clean-up plans throughout the basin. Private forest is one of the dominant land use types throughout the Snohomish basin (Pentec 1999). With continued implementation of the Forest Practices Act, conditions that limit or reduce habitat productivity and function in the upper watersheds should improve over time. In particular, bull trout may benefit from the maintenance of minimum riparian forest buffers, abandonment or improvement of forest roads, and other modern forest practices designed to minimize impacts and preserve riparian and instream functions and values. There is good reason to believe, however, it will be many years (tens of years) before instream conditions, including conditions in the action area, respond positively to the stricter and more protective land use controls in place today.

The State of Washington has begun planning and implementing various TMDL clean-up plans which may benefit Snohomish-Skykomish bull trout and designated critical habitat within the action area. These include an approved TMDL clean-up plan for dioxin in the lower Snohomish River, an approved TMDL clean-up plan for fecal coliform bacteria and a related pollution prevention plan for dissolved oxygen in the lower Snohomish River tributaries (including French Creek and Woods Creek), and a tentative temperature TMDL for a significant portion of the mainstem Snoqualmie River (extending from its mouth within the action area to a distance of more than 40 river miles upstream). Over the long-term, implementation of these various TMDL clean-up plans is expected to help achieve compliance with Washington's surface water quality criteria, an outcome that would benefit bull trout and other fish life.

Local actions which may affect Snohomish-Skykomish bull trout and designated critical habitat within the action area include planned growth consistent with the land use and growth management plans of Snohomish County and the City of Monroe. According to the City of Monroe's Comprehensive Plan (City of Monroe 2005), the UGA contains approximately 123 acres of vacant residential land capacity and approximately 163 acres of vacant commercial-industrial land capacity. The City of Monroe's Comprehensive Plan identifies the following land use planning "sub areas": Downtown Old Monroe, North Area/Milwaukee Hill, North Kelsey Area, Eastern City Limits, Eastern Commercial Area, Currie Road Sub Area, Robinhood Area, Evergreen Fairgrounds, Washington State Reformatory Area, Tester Road Area, 161st Avenue SE Area, and the Woods Creek Road/Old Owens Road Area (City of Monroe 2005). The Comprehensive Plan suggests that future growth and development are likely to be focused in the

Downtown Old Monroe, North/ Milwaukee Hill, North Kelsey, and 161st Avenue SE sub areas. Comparatively little future growth and development are expected in the other eight sub areas.

Within the City of Monroe UGA there are relatively few large tracts of land that are, as yet, undeveloped and which may develop in future years to more intensive uses consistent with zoning designations:

- *North Kelsey Development*: The City of Monroe expects the planned North Kelsey Development, located approximately 0.3 mile northeast of the SR 522 / US 2 interchange, will be the "major focal point of the city's expected new commercial growth [during] the next decade"(City of Monroe 2005). In the near-term, the City of Monroe expects to redevelop a portion of the North Kelsey Development area (roughly half the 100-acre site) consistent with the change in zoning (from general industrial to general commercial) approved in 2002; portions of the area have been leased for years by a local gravel mining operation.

- *Eastern City Limits, Evergreen State Fairgrounds, and the Reformatory Area*: The City of Monroe has evaluated the potential for growth in these areas and has found these areas are not good candidates (City of Monroe 2005). Further developing the agricultural area extending along US 2 to the City's easternmost boundary would require mitigation for extensive impacts to wetlands and/or floodplain. The Evergreen State Fairgrounds is a facility of regional and state significance and is administered by Snohomish County; no changes to the established uses are anticipated. The Reformatory Area is another public facility of statewide significance and no changes to the established uses are anticipated.

Additional residential, commercial, and industrial development (or redevelopment) may occur in the action area. The planned North Kelsey Development is a notable example. Both new development and redevelopment could affect the condition, health, and function of landscape features important to bull trout and to designated bull trout critical habitat within the action area. Planned growth consistent with the land use and growth management plans of Snohomish County and the City of Monroe could, over the long-term, result in additional effects to watershed functions, surface water quality, and instream habitat. However, the City's and County's Comprehensive Plans, Shoreline Management Programs, and Critical Area Ordinances, and State and County environmental permit requirements (including those requirements established for the protection of wetlands and floodplain and for the regulation of private and municipal stormwater discharges), should serve to reduce effects to ecological functions as additional portions of the UGA develop (or redevelop).

Taken as a whole, the foreseeable future State, Tribal, local and private actions will have effects to bull trout and designated critical habitat within the action area. Some of these actions (e.g., implementation of the Forest Practices Act and TMDL clean-up plans) are likely to improve conditions in the action area for bull trout. Other actions may, over time, further degrade conditions for bull trout in the action area.

CONCLUSION

The Service has reviewed the current status of bull trout in its coterminous range, the current status of designated critical habitat within the Puget Sound (Unit 28) and coterminous range, the environmental baseline for the action area, the direct and indirect effects of the proposed SR 522, Cathcart Road Vicinity to US 2 project, the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, Tribal, local, and private actions that are reasonably certain to occur in the action area.

It is the Service's Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout in its coterminous range. This determination is based on the following:

- The major rivers within the action area provide important FMO habitat for all anadromous bull trout of the Snohomish-Skykomish core area. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas (USFWS 2004b). Adult, subadult, and juvenile bull trout may occupy these waters at any time of year.

- The proposed action will adversely affect foraging and migrating adult, subadult, and juvenile bull trout. Temporary adverse effects include exposure to elevated underwater sound pressure levels and turbidity, and temporary effects on the condition and function of the migratory corridor. Permanent adverse effects include exposure to stormwater pollutants at concentrations sufficient to disrupt normal bull trout behaviors (sublethal effects), and permanent adverse effects to surface water quality and instream habitat.

- The proposed action incorporates both permanent design elements and conservation measures which will reduce effects to habitat and avoid and minimize impacts during construction. The action's temporary adverse effects are limited in both physical extent and duration. The action's permanent adverse effects will last in perpetuity (i.e., for the life of the project), but are limited in physical extent and episodic in nature. The direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from foraging, migrating or overwintering within the action area.

- With full implementation of the conservation measures, the Service expects only low numbers of adult, subadult, and juvenile bull trout will be exposed to construction activities and may suffer adverse effects. Exposure to construction activities may kill or injure a limited number of bull trout and will disrupt normal bull trout behaviors (feeding, moving, and sheltering). Individual bull trout may experience reduced growth, reproductive fitness (fecundity), and survival, but the Service has concluded that the action's temporary adverse effects will not measurably reduce the likelihood of persistence at the scale of the local populations or Snohomish-Skykomish core area.

- It is possible, over the long-term, that a large proportion of the anadromous bull trout of the Snohomish-Skykomish core area may be exposed to the action's permanent adverse effects, including effects to habitat function along a small portion of the migratory corridor. However, the Service has concluded that with full implementation of the proposed conservation measures and permanent design elements, the proposed action's effects to numbers (abundance), reproduction (productivity), distribution, and connectivity will not be measurable at the scale of the Snohomish-Skykomish core area or interim recovery unit. The Service expects the proposed action will not have a measurable effect on the relative size of the anadromous component contributing to the core area's local populations. The action's long-term effects will not measurably reduce the likelihood of persistence at the scale of the local populations or Snohomish-Skykomish core area.

- The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not appreciably reduce the likelihood of both survival and recovery of the species. The anticipated direct and indirect effects of the action (permanent and temporary) will not measurably reduce bull trout reproduction, numbers, or distribution at the scale of the core area or interim recovery unit. The anticipated direct and indirect effects of the action will not alter the status of bull trout at the scale of the interim recovery unit or coterminous range.

It is the Service's Biological opinion that the action, as proposed, will not destroy or adversely modify designated bull trout critical habitat. This determination is based on the following:

- The Service has designated the entire length of the Snohomish River, Snoqualmie River (upstream to Snoqualmie Falls), and mainstem Skykomish River (to the confluence of the North and South Forks) as critical habitat. The major rivers within the action area provide seven of the eight PCEs that define critical habitat and function as important FMO habitat for all anadromous bull trout of the Snohomish-Skykomish core area. The Snohomish-Skykomish core area plays a critical role in the conservation and recovery of bull trout, since each core area is vital to maintaining the overall distribution and genetic diversity of bull trout within the Puget Sound Management Unit (USFWS 2004b).

- The proposed action will have both temporary and permanent adverse effects to critical habitat, including effects to surface water quality and condition and function of the migratory corridor. The action's temporary adverse effects are limited in both physical extent and duration (not exceeding the 250-day period when in-water and over-water construction activities are being completed). The action's permanent adverse effects will last in perpetuity (i.e., for the life of the project), but are limited in physical extent and episodic in nature.

- The proposed action incorporates both permanent design elements and conservation measures which will reduce effects to designated critical habitat and avoid and minimize impacts during construction.

- The proposed action will, for the life of the project, impair function of the Skykomish River side-channel in the immediate vicinity of Bridge 522/138. The action's permanent adverse effects to PCE #s 2, 6, and 8 will be limited in physical extent, extending approximately 500 ft from the point of discharge (stormwater outfall from TDA 1), as far as the confluence with the mainstem Snohomish River. Permanent adverse effects will also be episodic, exposing only those bull trout in close proximity to the outfall from TDA 1 when stormwater discharges coincide with a low-flow condition. While the function of the Skykomish River side-channel and migratory corridor may at times be impaired, at other times (and in fact most of the time) effects to surface water quality and habitat function will not be measurable and will be of little or no significance to foraging and migrating bull trout.

- The direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from foraging, migrating or overwintering within the action area. Effects to habitat connectivity will be insignificant at the scale of the core area and interim recovery unit.

- Within the action area, designated bull trout critical habitat will remain functional. The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not prevent the PCEs of critical habitat from being maintained and functionally established at the scale of the action area. Critical habitat within the action area will continue to serve the intended conservation role for the species at the scale of the core area, interim recovery unit, and coterminous range.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR section 17.3). *Harass* in the definition of "take" in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR section 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the FHWA so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this incidental take statement. If the FHWA (1) fails to assume and implement the terms and conditions or (2) fails to require the contractor or applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FHWA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR section 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates that take in the form of harm and harassment of bull trout from the Snohomish-Skykomish core area is likely to result from the proposed action.

The Service anticipates that incidental take of individual bull trout will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured adults or subadults; 2) delayed mortality; and, 3) the relationship between habitat conditions and the distribution and abundance of individuals is imprecise such that a specific number of affected individuals cannot be practically obtained. Using post project habitat conditions as a surrogate indicator of take, the Service anticipates that the following forms of take will occur as a result of activities associated with the project:

1. Incidental take of bull trout in the form of ***harm*** (physical injury or mortality) as a direct effect of elevated underwater sound pressure levels resulting from impact installation and proofing of approximately 135 steel piles between July 1 and August 31, 2010 and 2011 (i.e., 40 to 60 days during each of two in-water construction seasons).

- All adult, subadult, and juvenile bull trout migrating, sheltering, or foraging within the wetted perimeter of the mainstem Snohomish River, Snoqualmie River, and Skykomish River (including the Skykomish River side-channel) to a distance of 1,775 ft upstream and downstream of piling installation operations will be harmed.

2. Incidental take of bull trout in the form of ***harassment*** (significant disruption or interference with normal behaviors) as a direct effect of elevated underwater sound pressure levels resulting from impact installation and proofing of approximately 135 steel piles between July 1 and August 31, 2010 and 2011 (i.e., 40 to 60 days during each of two in-water construction seasons).

- All adult, subadult, and juvenile bull trout migrating, sheltering, or foraging within the wetted perimeter of the mainstem Snohomish River, Snoqualmie River, and Skykomish River (including the Skykomish River side-channel) to a distance of 1 mile upstream and 2.6 miles downstream of piling installation operations will be harassed.

3. Incidental take of bull trout in the form of ***harm*** (physical injury or mortality) as a direct effect of elevated underwater sound pressure levels resulting from impact installation of "test" piles. A limited number of "test" piles may be driven without the use of a noise attenuation device between July 1 and August 31, 2010 and 2011 (i.e., approximately 5 days during each of two in-water construction seasons), when collecting real-time baseline data to describe unattenuated peak pressures and performance of the noise attenuation device.

- All adult, subadult, and juvenile bull trout migrating, sheltering, or foraging within the wetted perimeter of the mainstem Snohomish River, Snoqualmie River, and Skykomish River (including the Skykomish River side-channel) to a distance of 3,825 ft upstream and downstream of piling installation operations will be harmed.

4. Incidental take of bull trout in the form of ***harassment*** resulting from degraded surface water quality and exposure to elevated turbidity and sedimentation during construction. Water quality will be degraded intermittently during the 250-day period when in-water and over-water construction activities are being completed. Harassment will result when levels of turbidity reach or exceed the following:

    i) 67.0 NTUs above background at any time; or
    ii) 25.0 NTUs above background for more than 1 hour, cumulatively, over a 10-hour workday; or
    iii) 9.0 NTUs above background for more than 7 hours, cumulatively, over a 10-hour workday.

- All adult, subadult, and juvenile bull trout migrating, sheltering, or foraging within the wetted perimeter of the mainstem Snohomish River and Skykomish River side-channel, from a point approximately 100 ft upstream of the Snohomish River crossing, to a point approximately 300 ft downstream of the Snohomish River crossing, will be harassed between July 1 and December 31, 2010, and between July 1, 2011 and February 28, 2012.

5. Incidental take of bull trout in the form of ***harassment*** resulting from degraded surface water quality and exposure to elevated stormwater pollutant concentrations. Effects to surface water quality will last in perpetuity, but exposure and effects to bull trout will be episodic. Harassment will result when dissolved Cu concentrations exceed the sublethal neurotoxic threshold of an increase of 2.3 to 3.0 μg/L over background, or when dissolved Zn concentrations exceed 5.6 μg/L.

- All adult, subadult, and juvenile bull trout migrating, sheltering, or foraging within the wetted perimeter of the Skykomish River side-channel, from a point approximately 100 ft upstream of the outfall from TDA 1, to a point approximately 500 ft downstream, in perpetuity and for the life of the proposed project.

EFFECT OF THE TAKE

In the accompanying BO, the Service has determined that the level of anticipated take is not likely to result in jeopardy to the bull trout or destruction or adverse modification of designated bull trout critical habitat.

The proposed action incorporates design elements and conservation measures which the Service expects will reduce permanent effects to habitat and avoid and minimize impacts during construction. The Service assumes the FHWA will fully implement these measures and therefore they have not been specifically identified as Reasonable and Prudent Measures or Terms and Conditions.

REASONABLE AND PRUDENT MEASURES

The Service believes that the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize the impact of incidental take to bull trout:

1. Minimize and monitor incidental take caused by elevated underwater sound pressure levels resulting from impact installation (driving and proofing) of steel piles.

2. Maximize effectiveness of the noise attenuation device (i.e., confined bubble curtain or functional equivalent) so as to maintain a passable corridor through the action area during impact installation (driving and proofing) of steel piles. To the fullest extent practicable, prevent SPLs of 180 dB_{peak} and above from extending over more than 75 percent of the wetted channel width.

3. Minimize and monitor incidental take caused by elevated turbidity and sedimentation during construction.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. The FHWA and WSDOT shall conduct impact pile driving operations without the use of a noise attenuation device (i.e., confined bubble curtain or functional equivalent) only as necessary to determine baseline SPLs, and only as specified in the hydroacoustic monitoring plan.

2. The FHWA and WSDOT shall (a-h):

   a. Use a noise attenuation device composed of either a confined bubble curtain (i), or a functional equivalent (ii).

      i. A confined bubble curtain utilizing air compressor(s), supply lines to deliver air, distribution manifolds or headers, perforated aeration pipe(s), and a means of confining the bubbles; the bubble curtain shall (1-7):

         (1) Extend the confinement (e.g. fabric, plastic or metal sleeve, or equivalent) from the substrate to a sufficient elevation above the

maximum water level expected during pile installation such that when the air delivery system is adjusted properly, the bubble curtain does not act as a water pump (i.e., little or no water should be pumped out of the top of the confinement system).

(2) Contain resilient pile guides that prevent the pile and the confinement from coming into contact with each other and do not transmit vibrations to the confinement sleeve and into the water column (e.g. rubber spacers, air filled cushions).

(3) Use a single aeration ring at the substrate level in water less than 15 meters deep. In waters greater than 15 meters deep, the system shall have at least two rings, one at the substrate level and the other at mid-depth.

(4) Ensure that the lowest layer of perforated aeration pipe is in contact with the substrate without sinking into the substrate and shall accommodate for sloped conditions.

(5) Size the air holes 1.6 mm (1/16-inch) in diameter and space them approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in four adjacent rows along the pipe to provide uniform bubble flux.

(6) Provide a bubble flux of 3.0 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$$V_t = 3.0 \text{ m}^3/\text{min/m} * \text{Circ of the aeration ring in m}$$

or

$$V_t = 32.91 \text{ ft}^3/\text{min/ft} * \text{Circ of the aeration ring in ft}$$

(7) Provide meters as follows:

(a) Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.

(b) Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.

(c) Flow meters shall be installed according to the manufacturer's recommendation based on either laminar flow or non-laminar flow.

ii. A functional equivalent to the design described above (2.a.i.). Design specifications and monitoring reports or other information documenting equivalent function shall be submitted to the Service for review a minimum of 60 days prior to impact pile driving.

b. Submit a hydroacoustic monitoring plan for review a minimum of 45 days prior to impact pile driving. The hydroacoustic monitoring plan shall follow the Service-approved generic monitoring plan (with site-specific details where appropriate), shall be prepared and implemented by someone with proven expertise in the field of underwater acoustics and data collection, and shall include the name and qualifications of the biologist to be present during impact pile driving.

c. Conduct a performance test of the noise attenuation device, prior to any impact pile driving. If a confined bubble curtain is utilized, the performance test shall confirm the calculated pressures and flow rates at each manifold ring. The FHWA and/or WSDOT shall submit an inspection/performance report to the Service within 72 hours following the performance test.

d. Ensure that a qualified biologist is present during all impact pile driving operations to observe and report any indications of dead, injured or distressed fish, including direct observations of fish or increases in bird foraging activity.

e. Isolate any barges used to house the pile driver from the noise-producing operations. This isolation shall be such that noise from the pile driving operation is not transmitted through the barge to the water column.

f. Document the effectiveness of the noise attenuation device through hydroacoustic monitoring of a minimum of five piles, as early in the project as possible. Factors to consider in identifying the piles to be monitored include, but are not limited to: bathymetry of the project site, total number of piles to be driven, sizes of piles, and distance from shore. This monitoring shall include SPLs (peak and rms), and sound exposure levels (SELs), with and without use of the noise attenuation device, monitored at a distance of 10 meters from the pile at mid-water depth.

g. Contact the Service within 24 hours if the hydroacoustic monitoring indicates that the SPLs will exceed the extent of take exempted in the Biological Opinion. The FHWA shall consult with the Service regarding modifications to the proposed action in an effort to reduce the SPLs below the limits of take and continue hydroacoustic monitoring.

h. Submit a monitoring report to the consulting biologist(s) at the Service within 60 days of completing hydroacoustic monitoring. The report shall include the following information:

   i. Size and type of piles driven;

   ii. A detailed description of the noise attenuation device, including the design specifications identified above;

   iii. The impact hammer force used to drive the piles;

   iv. A description of the monitoring equipment;

   v. The distance between hydrophone and pile;

   vi. The depth of the hydrophone;

   vii. The distance from the pile to the wetted perimeter;

   viii. The depth of water the pile was driven;

   ix. The depth into the substrate the pile was driven;

   x. The physical characteristics of the bottom substrate into which the piles were driven; and

   xi. The results of the hydroacoustic monitoring, including the frequency spectrum, SPLs (peak and rms), and single-strike and cumulative SEL with and without the noise attenuation device. The report must also include the ranges and means for peak, rms and SELs for each pile.

The following terms and conditions are required for the implementation of RPM 2:

1. The FHWA and WSDOT shall, to the fullest extent practicable and through design, testing, and careful implementation, maximize effectiveness of the noise attenuation device with the goal of achieving a target of 20 dB attenuation measured at a distance of 10 meters from the pile. Based on information included in the BA, unattenuated peak pressure is expected to be 211 dB. As such, the noise attenuation device will need to achieve 20 dB attenuation (at a distance of 10 meters) in order to prevent SPLs of 180 dB_{peak} and above from extending over more than 75 percent of the wetted channel width.

The following terms and conditions are required for the implementation of RPM 3:

1. The FHWA and WSDOT shall monitor downstream turbidity levels in the mainstem Snohomish River and Skykomish River side-channel during sediment-generating

activities. The FHWA and WSDOT shall monitor downstream turbidity during in-water construction and in the event that any portion of the Snohomish-Skykomish floodplain under active construction becomes inundated by seasonal high-flows (including the temporary haul roads).

2. Monitoring shall be conducted at a distance of 150 ft downstream of construction activities.

3. Monitoring shall be conducted at three locations along a transect extending perpendicular to flow; to the extent practicable, one sample location shall be positioned along the transect near the mid-point of the wetted channel.

4. Monitoring shall be conducted at 15-minute intervals for the first 2 hours during each day of in-water construction. If turbidity does not exceed 5 NTUs over background during that time, then additional monitoring will be conducted for the remainder of the workday at a frequency of once every 3 hours. If at anytime a sample exceeds 5 NTUs over background, monitoring shall be conducted at 15-minute intervals until turbidity falls below 5 NTUs over background.

5. If monitoring conducted 150 ft downstream of construction activities indicates turbidity in excess of 9.0 NTUs over background (concentration at which take may result), then monitoring shall instead be conducted at 300 ft downstream of construction activities. Monitoring shall be conducted at 15-minute intervals until turbidity falls below 9.0 NTUs over background.

6. If turbidity levels measured at 300 feet downstream of construction activities exceed 9.0 NTUs over background for more than 7 hours cumulatively over any 10-hour workday (or 25.0 NTUs over background for more than 1 hour), then the amount of take authorized by the Incidental Take Statement will have been exceeded. Sediment-generating activities will cease, and FHWA must reinitiate consultation. The FHWA and/or WSDOT shall contact the Service's consulting biologist (Ryan McReynolds; 360-753-6047) at the Western Washington Fish and Wildlife Office in Lacey, Washington.

7. Additional monitoring shall be conducted to establish background turbidity levels upstream and away from the influence of construction activities. Background turbidity shall be monitored at least once daily during sediment-generating activities. In the event of a visually appreciable change in background turbidity, an additional sample shall be taken.

8. The FHWA and WSDOT shall submit a monitoring report by December 31 of each year of construction, to include at a minimum, the following: (a) Dates and times of construction activities; (b) Monitoring results; sample times, locations, and measured turbidities (in NTUs); (c) Summary of construction activities and measured turbidities associated with those activities; and, (d) Summary of corrective actions taken to reduce sediment/turbidity.

The Service expects that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The FHWA must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Services's Western Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends the following to the FHWA:

1. To the fullest extent practicable, drive temporary steel piling with the use of a vibratory hammer. Vibratory hammers produce lower peak pressures and impulse energies than do impact hammers, and produce sound energy concentrated at frequencies that are less harmful to fish and other aquatic organisms.

2. Infiltrate and/or disperse treated stormwater runoff to the fullest extent practicable. Select, site, and design stormwater runoff treatment and flow control facilities so as to minimize direct discharges to fish bearing waterbodies.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR section 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

LITERATURE CITED

Abbott, R.R., E. Bing-Sawyer, and R. Blizard. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Orthodon microlepidotus*). Administrative draft. Caltrans, Oakland, California.

Abbott, R.R., J.A. Reyff, and G. Marty. 2005. Monitoring the effects of conventional pile driving on three species of fish. Prepared by Strategic Environmental Consulting for Manson Construction Company, Richmond, California.

Angermeier, P.L., A.P. Wheeler, and A.E. Rosenberger. 2004. A conceptual framework for assessing impacts of roads on aquatic biota. Fisheries 29(12):19-29.

Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry 22(10):2266-74.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington, Seattle, Washington.

Berg, L., and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Beyerlein, D. 1999. Why standard stormwater mitigation doesn't work. *In* Proceedings: Water Management to Protect Declining Species. Annual Water Resources Conference, American Water Resources Association, Seattle, Washington.

Brenkman, S., and S. Corbett. 2003a. Seasonal movements of threatened bull trout (*Salvelinus confluentus*) in the Hoh River basin and coastal Washington. Abstract. Northwest Scientific Association meeting 2003, Forks, Washington. *Cited in* U.S. Fish and Wildlife Service. 2004b. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*). Region 1 Ecological Services, Portland, Oregon.

Brenkman, S., and S. Corbett. 2003b. Radio tracking of bull trout in the Hoh basin and coastal Washington. Flight summary for 04/25/03. Draft. *Cited in* U.S. Fish and Wildlife Service. 2004b. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*). Region 1 Ecological Services, Portland, Oregon.

Burton, G., R. Pitt, and S. Clark. 2000. The role of traditional and novel toxicity test methods in assessing stormwater and sediment contamination. Critical Reviews in Environmental Science and Technology 30(4):413-447.

Carlson, T.J., G. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland, and P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigational channel and channel maintenance activities. Pacific Northwest National Laboratory, U.S. Department of Energy (prepared for the U.S. Army Corps of Engineers - Portland District). PNNL-13595. 38 pp.

Carroll, J. and K. Thornburg. 1997. French Creek watershed characterization (Snohomish County, Washington). Prepared for the French Creek Watershed Committee and Snohomish County Public Works. October, 1997, 74pp. < http://www.co. snohomish.wa.us/documents/Departments/Public_Works/surfacewatermanagement/ watershed/fr_cr_wshed_mgmt_plan_tech_sup/FC_Water_Chart_ztn_Rpt_4.pdf> Accessed 6/15/2007.

Cederholm, C.J., and L.M. Reid. 1987. Impact of forest management on coho salmon (*Oncoryhynchus isutch*) populations of the Clearwater River, Washington: a project summary. Pages 373-398 in Salo, E.O., and T.W. Cundy, editors. Streamside Management: Forestry and Fishery Interactions. University of Washington Institute of Forest Resources Contribution 57.

City of Monroe, Washington. 2005. City of Monroe comprehensive plan (2005-2025) – executive summary, land use element, map, and economic development element. <http://www.ci.monroe.wa.us/citygov/depts/community_development/planning/planning.php> Accessed 11/15/2007.

City of Monroe, Washington. 2007a. City of Monroe zoning districts map. <http://www.ci.monroe.wa.us/citygov/depts/community_development/planning/ZoningMap.pdf > Accessed 11/15/2007.

City of Monroe, Washington. 2007b. City of Monroe shoreline master program. October 2007, 194pp. <http://www.ci.monroe.wa.us/citygov/depts/community_development/ planning/shorelinemasterprogram.pdf> Accessed 12/15/2007.

Crum, L.A. and Y. Mao. 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. Journal of the Acoustical Society of America 99(5):2898-907.

Davidson, M. 2004. Transmission Loss. University of Plymouth, Drake Circus, Plymouth, Devon, UK. <http://freespace.virgin.net/mark.davidson3/TL/ TL.html>. Accessed 6/15/2007.

Eisler, R. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: a Synoptic Review. Biological Report 10. United States Fish and Wildlife Service, Patuxent Wildlfe Research Center, Laurel, Maryland, 106 pp.

Eisler, R. 1998. Copper hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Science Report USGS/BRD/BSR--1997-0002. Biological Resources Division, U.S. Geological Survey, 120 pp.

EPA (U.S. Environmental Protection Agency). 1980. Ambient Water Quality Criteria for Copper. Publication 440/5-80-036. Criteria and Standards Division, Office of Water Regulations and Standards, Washington, D.C., 162 pp.

EPA (U.S. Environmental Protection Agency). 1987. Ambient water quality criteria for zinc -1987. U.S. Environmental Protection Agency Report 440/5-87-003. 207 pp. *In* Eisler, R. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: a Synoptic Review. Biological Report 10. United States Fish and Wildlife Service, Patuxent Wildlfe Research Center, Laurel, Maryland, 106 pp.

Federal Highway Administration. 2006. Biological Assessment: SR 522, Cathcart Road Vicinity to US 2 (HFO-WA.4/SR 522 General). Washington Division, Olympia, Washington.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1992. Potential impacts of pile driving on juvenile pink (*Onchorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. University of Washington, Seattle, WA.

Fewtrell, J.L. 2003. The response of marine finfish and invertebrates to seismic survey noise. Curtin University of Technology, Perth, Australia.

Folmar, L. 1976. Overt avoidance reaction of rainbow trout fry to nine herbicides. Bulletin of Environmental Contamination & Toxicology 15(5):509-14.

Gersib, R.A., S. Grigsby, C. Freeland, and K. Bauerfield. 1999. Process-based river basin characterization: a case study – Snohomish Basin, Washington (Draft). Washington State Department of Ecology, Olympia, Washington. *In* Haring, D. 2002. Salmonid habitat limiting factors analysis (Snohomish River Watershed, Water Resource Inventory Area 7 - Final Report). Washington State Conservation Commission. December 2002.

Ghanmi, Z., M. Rouabhia, O. Othmane, and P.A. Deschaux. 1989. Effects of metal ions on cyprinid fish immune response: invitro effects of Zn2+ and Mn2+ on the mitogenic response of carp pronephros lymphocytes. Ecotoxicology and Environmental Safety 17(2):183-89.

Gisiner, R.C., E. Cudahy, G.V. Frisk, R. Gentry, R. Hofman, A.N. Popper, and J.W. Richardson. 1998. Workshop on the effects of anthropogenic noise in the marine environment. *In* Gisiner, R.C., ed. Effects of Anthropogenic Noise in the Marine Environment. Marine Mammal Science Program, Office of Naval Research, 141 pp.

Hansen, J.A., P.G. Welsh, J. Lipton, D. Cacela, and A.D. Dailey. 2002. Relative sensitivity of bull trout (*Salvelinus confluentus*) and rainbow trout (*Oncorhynchus mykiss*) to acute exposures of cadmium and zinc. Environmental Toxicology and Chemistry 21(1):67-75.

Haring, D. 2002. Salmonid habitat limiting factors analysis (Snohomish River Watershed, Water Resource Inventory Area 7 - Final Report). Washington State Conservation Commission. December 2002.

Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Ohio State University, Columbus, Ohio.

Hastings, M.C. and A.N. Popper. 2005. Effects of sound on fish. Contract 43A0139 Task Order, 1. California Department of Transportation, Sacramento, California, 82 pp.

Hawkins, A.D. and A.D.F. Johnstone. 1978. The hearing of the Atlantic Salmon, *Salmo salar*. Journal of Fish Biology 13:655-73.

Herrera Environmental Consultants, Inc. 2007. Untreated highway runoff in western Washington - draft white paper (May 16, 2007). Prepared for the Washington State Department of Transportation. 66 pp.

Hilmy, A.M., N.A. Eldomiaty, A.Y. Daabees, and H.A.A. Latife. 1987a. Some physiological and biochemical indexes of zinc toxicity in 2 fresh-water fishes, *Clarias lazera* and *Tilapia zilli*. Comparative Biochemistry and Physiology, C 87C(2):297-301.

Hilmy, A.M., N.A. Eldomiaty, A.Y. Daabees, and H.A.A. Latife. 1987b. Toxicity in *Tilapia zilli* and *Clarias lazera* (*Pisces*) induced by zinc, seasonally. Comparative Biochemistry and Physiology, C 86C(2):263-65.

Houghton, J.P. and K. Smith. 2005. 12th Street Marina construction - preliminary pile monitoring results. Port of Everett, Washington.

Kardouni, J. and N. Cristea. 2006. Quality assurance plan – Snoqualmie River temperature total maximum daily load study. Publication Number 06-03-106 (July 2006). Washington State Department of Ecology, Olympia, Washington. 55 pp.

Kayhanian, M., A. Sing, S. Suverkropp, and S. Borroum. 2003. Impact of annual average daily traffic on highway runoff pollutant concentrations. Journal of Environmental Engineering 129(11):975-90.

Keevin, T.M., G.L. Hempen, and D.J. Schaeffer. 1997. Use of a bubble curtain to reduce fish mortality during explosive demolition of Locks and Dam 26, Mississippi River. Pages 197-206. *In* Proceedings of the Twenty-third Annual Conference on Explosive and

Blasting Technique. Las Vegas, Nevada. International Society of Explosives Engineers, Las Vegas, Nevada.

Knudsen, F.R., P.S. Enger, and O. Sand. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar*. Journal of Fish Biology 40:523-34.

Knudsen, F.R., C.B. Schreck, S.M. Knapp, P.S. Enger, and O. Sand. 1997. Infrasound produces flight and avoidance responses in Pacific juvenile salmonids. Journal of Fish Biology 51:824-29.

Laughlin, J. 2005. Underwater sound levels associated with restoration of the Friday Harbor Ferry Terminal. Washington State Department of Transportation, Seattle, Washington.

Laughlin, J. 2006. Underwater sound levels associated with pile driving at the Cape Disappointment Boat Launch Facility, Wave Barrier Project (Revised). Washington State Parks.

Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Fraser River Pile and Dredge Ltd., New Westminster, British Columbia, Canada.

MacGillivray, A. and R. Racca. 2005. Sound pressure and particle velocity measurements from marine pile driving at Eagle Harbor maintenance facility, Bainbridge Island, WA. Prepared for Washington State Department of Transportation by JASCO Research Ltd., Victoria, British Columbia.

May, C.W., R.R. Horner, J.R. Karr, B.W. Mar, and E.B. Welch. 1997. Effects of urbanization on small streams in the Puget Sound lowland ecoregion. Watershed Protection Techniques 2(4):483-94.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. Transactions of the American Fisheries Society 123(5):786-93.

Mueller, R.P., D.A. Neitzel, W.V. Mavros, and T.J. Carlson. 1998. Evaluation of low and high frequency sound for enhancing fish screening facilities to protect outmigrating salmonids. Project No. 86-118. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, 26 pp.

Nedwell, J. and B. Edwards. 2002. Measurements of underwater noise in the Arun River during piling at County Wharf, Littlehampton. Report No. 513 R 0108. Subacoustech Ltd.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16:693-727.

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11:72-82.

Niyogi, S., P. Couture, G. Pyle, D.G. McDonald, and C.M. Wood. 2004. Acute cadmium biotic ligand model characteristics of laboratory-reared and wild yellow perch (*Perca flavescens*) relative to rainbow trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Science 61:942-53.

Onwumere, G. 2003. Effectiveness monitoring for dioxin total maximum daily loads in western Washington. Publication Number 03-03-002 (January 2003). Washington State Department of Ecology, Olympia, Washington. 14 pp.

Pentec Environmental, Inc. and NW GIS. 1999. Snohomish River basin conditions and issues report - revised final report (December 17, 1999). Prepared for Snohomish River Basin Work Group (Project No. 293-001). 315 pp.

Playle, R.C. 2004. Using multiple metal-gill binding models and the toxic unit concept to help reconcile multiple-metal toxicity results. Aquatic Toxicology 67(4):359-70.

Pommerenck, K. 2006. Results of underwater sound measurements for the construction of utility crossing at Stockton Regional Wastewater Control Facility. Illingworth and Rodkin, Inc., Petaluma, California, 2 pp.

Popper, A.N. 2003. Effects of anthropogenic sounds on fishes. Fisheries 28(10):24-31.

Popper, A.N., T.J. Carlson, A.D. Hawkins, B.L. Southall, and R. Gentry. 2006. Interim criteria for injury of fish exposed to pile driving operations: a white paper.

SAIC 2002. Washington SR 522 road widening and mitigation, draft preliminary (40 percent) design report. Prepared for the Washington State Department of Transportation. *In* Washington State Department of Transportation. 2003. Site and Reach Assessment: SR 522/138 Snohomish River Bridge (Technical Recommendations Report). Olympia, Washington. May 2003.

Santulli, A., A. Modica, C. Messina, L. Ceffa, A. Curatolo, G. Rivas, G. Fabi, and V. D'Amelio. 1999. Biochemical responses of European sea bass (*Dicentrarchus labrax*) to the stress induced by off shore experimental seismic prospecting. Marine Pollution Bulletin 38(12):105-14.

Schueler, T.R. 1987. Controlling urban runoff: a practical manual for planning and design of urban BMPs. Metropolitan Washington Council of Governments, Washington, D.C., 275 pp.

Shin, H.O. 1995. Effect of the piling work noise on the behavior of snakehead (*Channa argus*) in the aquafarm. J. Korean Fish. Soc. 28(4):492-502.

Snohomish County, Department of Planning and Development Services. 2007a. Snohomish County permit, planning, and zoning map. < http://gis.co.snohomish.wa.us/maps/permits/index.htm> Accessed 6/15/2007.

Snohomish County, Department of Planning and Development Services. 2007b. Snohomish County comprehensive plan. <http://www1.co.snohomish.wa.us/Departments/PDS/Divisions/LR_Planning/Projects_Programs/Comprehensive_Plan/> Accessed 6/15/2007.

Spear, P. A. 1981. Zinc in the aquatic environment: chemistry, distribution, and toxicology. National Research Council of Canada, Publication NRCC 17589, 145 pp. *In* Eisler, R. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: a Synoptic Review. Biological Report 10. United States Fish and Wildlife Service, Patuxent Wildlfe Research Center, Laurel, Maryland, 106 pp.

Sprague, J.B. 1964. Avoidance of copper-zinc solutions by young salmon in the laboratory. Journal - Water Pollution Control Federation 36:990-1004.

Sprague, J.B. 1968. Avoidance reactions of rainbow trout to zinc sulphate solutions. Water Research 2:367-372.

Sprague, J.B. and J.A. Ramsay. 1965. Lethal levels of mixed copper-zinc solutions for juvenile salmon. Journal of the Fisheries Research Board of Canada 22(2):425-32.

Stadler, J.H. 2002. Notes from site visit, Winslow Ferry Terminal, to observe pile driving and monitoring of noise levels and effects to fishes.

Stotz, T. and J. Colby. 2001. Dive Report for Mukilteo Wingwall Replacement Project. Washington State Ferries, Seattle, Washington, January 2001.

Stroetz, R.W., N.E. Vlahakis, B.J. Walters, M.A. Schroeder, and R.D. Hubmayr. 2001. Validation of a new live cell strain system: characterization of plasma membrane stress failure. Journal of Applied Physiology 90:2361-70.

Svrjcek, R. 2003. Lower Snohomish River tributaries fecal coliform bacteria total maximum daily load: detailed implementation plan. Publication Number 03-10-031 (June 2003). Washington State Department of Ecology, Olympia, Washington. 94 pp.

Turnpenny, A. and J. Nedwell. 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Fawley Aquatic Research Laboratories Limited, Marine and Freshwater Biology Unit, Southampton, Hampshire, UK, 48 pp.

Turnpenny, A., K.P. Thatcher, R. Wood, and J. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Report FRR 127/94. Fawley Aquatic Research Laboratory, Ltd., Marine and Freshwater Biology Unit, Southampton, United Kingdom.

U.S. Fish and Wildlife Service. 1998. A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. Western Washington Fish and Wildlife Office, Lacey, Washington, 45pp.

U.S. Fish and Wildlife Service. 2003. Biological Opinion: State Route 522, Paradise Lake Road to Cathcart Road Widening and Interchange Improvements (FWS Ref. No. 1-3-02-F-1161). Western Washington Fish and Wildlife Office, Lacey, Washington.

U.S. Fish and Wildlife Service. 2004a. Biological Opinion – Snohomish River Bridge 522/138 Scour Repair Project (FWS Ref. No. 1-3-04-F-0007). Western Washington Fish and Wildlife Office, Lacey, Washington.

U.S. Fish and Wildlife Service. 2004b. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*). Region 1 Ecological Services, Portland, Oregon.

U.S. Fish and Wildlife Service. 2006. Framework for assessing sediment impacts. Western Washington Fish and Wildlife Office, Lacey, Washington, 21pp.

U.S. Fish and Wildlife Service. 2007. Biological Opinion – Proposed State Route 167 Extension (FWS Ref. No. 1-3-05-F-0688). Western Washington Fish and Wildlife Office, Lacey, Washington, 101pp.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered species consultation handbook: procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act. U.S. Department of the Interior and U.S. Department of Commerce, Washington D.C., March 1998.

U.S. Geological Survey. 2007. National water information system (12150800 - Snohomish River near Monroe, WA). <<http://wa.water.usgs.gov/cgi/adr.cgi?12150800>>. Accessed 5/5/2007.

Van Metre, P.C., B.L. Mahler, and E.L. Furlong. 2000. Urban sprawl leaves its PAH signature. Environmental Science and Technology 34:4064-70.

Vlahakis, N.E. and R.D. Hubmayr. 2000. Plasma membrane stress failure in alveolar epithelial cells. Journal of Applied Physiology 89:2490-96.

Washington State Department of Ecology. 1999. 303(d) Water Quality Assessment (1998 Final Category 4 and 5 Listings). <<http://www.ecy.wa.gov/programs/wq/303d/1998/1998-index.html >>. Accessed 5/5/2007.

Washington State Department of Ecology. 2005a. 303(d) Water Quality Assessment (2004 Final Category 1 Listings). <<http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/wria_pdfs-5final/kk-active-1.pdf>>. Accessed 5/5/2007.

Washington State Department of Ecology. 2005b. 303(d) Water Quality Assessment (2004 Final Category 4 and 5 Listings). <<http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/wq_assessment_cats2004.html>>. Accessed 5/5/2007.

Washington State Department of Ecology. 2006. Water quality standards for surface waters of the State of Washington, Chapter 173-201A WAC (06-10-091). Olympia, Washington.

Washington State Department of Ecology. 2007a. River and stream water quality monitoring network (Station 07C070 - Skykomish River at Monroe). <<http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07C070>>. Accessed 5/5/2007.

Washington State Department of Ecology. 2007b. River and stream water quality monitoring network (Station 07D050 - Snoqualmie River near Monroe). <<http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07D050>>. Accessed 5/5/2007.

Washington State Department of Ecology. 2007c. River and stream water quality monitoring network (Station 07A090 - Snohomish River at Snohomish). <<http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07A090>>. Accessed 5/5/2007.

Washington State Department of Ecology, and Washington State Department of Transportation. 1998. Implementing agreement regarding compliance with the State of Washington surface water quality standards. February 13, 1998.

Washington State Department of Fish and Wildlife. 2002. Washington state salmon and steelhead stock inventory. Olympia, Washington.

Washington State Department of Fish and Wildlife. 2004. Washington state salmon and steelhead stock inventory (Bull Trout/Dolly Varden). Olympia, Washington.

Washington State Department of Fish and Wildlife. 2007a. Salmonscape (interactive computer mapping system). <http://wdfw.wa.gov/mapping/salmonscape/> Accessed 4/5/2007.

Washington State Department of Fish and Wildlife. 2007b. Bull trout report (2006). Section 6(c)(1) Endangered Species Act Report to the U.S. Fish and Wildlife Service on hatchery, stock assessment, and research activities that have the potential to take listed Washington Coastal-Puget Sound DPS bull trout (*Salvelinus confluentus*). Olympia, Washington.

Washington State Department of Fish and Wildlife, and Washington State Department of Transportation. 2007. WSDOT Fish Passage Inventory Progress Performance Report. Olympia, Washington. May 2007. 59pp.

Washington State Department of Transportation. 1996. Roadside classification plan. Olympia, Washington, 70pp.

Washington State Department of Transportation. 2003. Site and Reach Assessment: SR 522/138 Snohomish River Bridge (Technical Recommendations Report). Olympia, Washington. May 2003.

Washington State Department of Transportation. 2005. Standard specifications for road, bridge, and municipal construction (2006). Publication M 41-10. Olympia, Washington.

Washington State Department of Transportation. 2006a. Guidance for preparing the stormwater section of Biological Assessments. Olympia, Washington. November 13, 2006. 24pp.

Washington State Department of Transportation. 2006b. Highway runoff manual (2006 Revision). Publication M 31-16. Olympia, Washington.

Washington State Department of Transportation. 2006c. 2006 Stormwater Report. Olympia, Washington. September 2006. 107pp.

Washington State Department of Transportation. 2007a. Standard specifications for road, bridge, and municipal construction (2008). Publication M 41-10. Olympia, Washington.

Washington State Department of Transportation. 2007b. Advanced training manual - biological assessment preparation for transportation projects (part 2). Environmental Services Office, Olympia, Washington, 295pp.

Washington State Department of Transportation. 2007c. Technical memorandum – SR 522 stormwater pond 3A discharge to Snohomish River side channel. September 26, 2007.

Waters, Thomas F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7.

Watson, G. and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17(2):237-252.

Wheeler, A.P., P.L. Angermeier, and A.E. Rosenberger. 2005. Impacts of new highways and subsequent landscape urbanization on stream habitat and biota. Reviews in Fisheries Science 13:141-64.

Yelverton, J.T., D.R. Richmond, R.E. Fletcher, and R.K. Jones. 1973. Safe distance from underwater explosions for mammals and birds. Lovelace Foundation for Medical Education and Research, Albuquerque, NM, 64 pp.

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and R.E. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Lovelace Foundation for Medical Education and Research, Albuquerque, NM.

Yelverton, J.T. and D.R. Richmond. 1981. Underwater explosion damage risk criteria for fish, birds, and mammals. *In* 102nd Meeting of the Acoustical Society of America, 36, November 30 - December 04, Miami Beach, Florida. Department of Biodynamics, Lovelace Biomedical and Environmental Research Institute, Alberquerque, New Mexico. 36 pp.

Young, G.K., S. Stein, P. Cole, T. Krammer, F. Graziano, and F. Bank. 1996. Evaluation and management of highway runoff water quality. Publication No. FHWA-PD-96-032. Federal Highway Administration, Washington, D.C., 457 pp.

PERSONAL COMMUNICATIONS

Bloodgood, J. 2006. Traffic Engineer. Snohomish County Public Works, Everett, Washington. *In* Federal Highway Administration. 2006. Biological Assessment: SR 522, Cathcart Road Vicinity to US 2 (HFO-WA.4/SR 522 General). Washington Division, Olympia, Washington.

Chan, J. 2007. Fish and Wildlife Biologist. U.S. Fish and Wildlife Service, Western Washingon Fish and Wildlife Office, Lacey, Washington.

Gathmann, T. 2006. City of Monroe, Monroe, Washington. *In* Federal Highway Administration. 2006. Biological Assessment: SR 522, Cathcart Road Vicinity to US 2 (HFO-WA.4/SR 522 General). Washington Division, Olympia, Washington.

Goetz, F. 2002. U.S. Army Corps of Engineers, Seattle, Washington. *In* U.S. Fish and Wildlife Service. 2004a. Biological Opinion – Snohomish River Bridge 522/138 Scour Repair Project (FWS Ref. No. 1-3-04-F-0007). Western Washington Fish and Wildlife Office, Lacey, Washington.

Hirsh, D. 2007. Administrative and Policy Support Team Leader. National Marine Fisheries Service, Washington State Habitat Office, Lacey, Washington.

Kramer, C. 2003. Fisheries Biologist. Washington State Department of Fish and Wildlife, Mill Creek, Washington. *In* U.S. Fish and Wildlife Service. 2004a. Biological Opinion – Snohomish River Bridge 522/138 Scour Repair Project (FWS Ref. No. 1-3-04-F-0007). Western Washington Fish and Wildlife Office, Lacey, Washington.

MacDonald, M. 2007. Biologist, Washington State Department of Transportation, Shoreline, Washington.

LITERATURE CITED (STATUS OF THE SPECIES)

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Ph.D. Thesis, Oregon State University, Corvallis, Oregon.

Baxter, J.S., E.B. Taylor, R.H. Devlin, J. Hagen and J.D. McPhail. 1997. Evidence for natural hybridization between Dolly Varden (*Salvelinus malma*) and bull trout (*S. confluentus*) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

Beauchamp, D.A., and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-216.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in the foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 *in* Howell, P.J., and D.V. Buchanan (eds.). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Bonneau, J.L., and D.L. Scarnecchia 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125(4):628-630.

Brenkman, S.J., and S.C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25:1073-1081.

Brewin, P.A., and M.K. Brewin. 1997. Distribution maps for bull trout in Alberta. Pages 209-216 *in*: MacKay, W.C., M.K. Brewin, and M.Monia (eds.). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary.

Brown, L.G. 1994. The zoogeography and life history of WA native charr. Report #94-04 November 1992. Washington Department of Fish and Wildlife, Fisheries Management Division, Olympia, Washington.

Buchanan, D.M., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 1-8 *in*: Mackay, W.C., M.K. Brewin and M. Monita (eds.). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, (*Salvelinus confluentus*) (Suckley), from the American Northwest. California Fish and Game 64(3):139-174.

Donald, D.B., and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71:238-247.

Dunham, J.B., B.E. Rieman, and G. Chandler. 2003. Influence of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-904.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology, and subpopulation status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File report Number 156-99. Flathead Lake Biological Station, University of Montana. Polson, Montana.

Frissell, C.A. 1993. Topology of extinction and endangerment of native fishes in the Pacific Northwest and California. Conservation Biology 7(2):342-354.

Gerking, S.D. 1994. Feeding Ecology of Fish. Academic Press, San Diego, California.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. Willamette National Forest, Eugene, Oregon.

Goetz, F.A., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Idaho Department of Fish and Game, *in litt. 1995.* List of streams compiled by IDEG where bull trout have been extirpated, fax from Bill Horton, IDFG, to Trish Klahr, U.S. Fish and Wildlife Service, Boise, Idaho. 3 pp.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A., and P. Graham. 1982. Flathead Lake fish food habits study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. Contract R008224-01-4 to Montana Department of Fish, Wildlife, and Parks.

(MBTSG) The Montana Bull Trout Scientific Group. 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for the Montana Bull Trout Restoration Team, Montana Fish, Wildlife, and Parks, Helena, Montana. 85pp.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries Management Report No. 104. Department of Zoology, University of British Columbia, Vancouver, British Columbia.

McPhail, J.D., and C. Murray. 1979. The early life history of Dolly Varden *(Salvelinus malma)* in the upper Arrow Lakes. Report to the British Columbia Hydro and Power Authority and Kootenai Department of Fish and Wildlife. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, British Columbia.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds. Peer review summary prepared for U.S. Fish and Wildlife Service.

Pratt, K.L. 1985. Habitat use and species interactions of juvenile cutthroat, *Salmo clarki*, and bull trout, *Salvelinus confluentus*, in the upper Flathead River basin. Masters Thesis, University of Idaho, Moscow.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 *in*: Howell, P.J., and D.V. Buchanan (eds.). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in lake Pend Oreille and the lower Clark Fork River. Draft report. Prepared for the Washington Water Power Company, Spokane, Washington.

Quigley, Thomas M., and Sylvia J. Arbelbide (tech. eds.). 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins. Portland, Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station 3:1174-1185.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10 - 17 *in*: Howell, P.J. and D.V. Buchanan (eds.). Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. Masters Thesis, Montana State University, Bozeman.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-302, Ogden, Utah. 38 pp.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124 (3):285-296.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B.E., D.C. Lee, and R.F. Thurow. 1997. Distribution, status and likely future trends of bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125.

Rieman, B.E., D. Lee, D. Burns, R. Gresswell, M. Young, R. Stowell, P. Howell. 2003. Status of native fishes in western United States and issues for fire and fuels management. Forest Ecology and Management 178(1-2):197-211.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing. Draft U.S. Department of Agriculture Report, Pacific Northwest Research Station, Corvallis, Oregon.

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile trout in four streams located in the eastern Cascades, Washington. Pages 361-170 *in*: MacKay, W.C., M.K. Brewin, and M. Monita (eds.). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University of Idaho Press, Moscow, Idaho.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of bull trout populations. Ecology of Freshwater Fish 8:114-121.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

U.S. Fish and Wildlife Service. 2002. Bull trout (*Salvelinus confluentus*) draft recovery plan. Chapter One. Fish and Wildlife Service, Portland, Oregon. 137 pp.

U.S. Fish and Wildlife Service. 2004a. Draft recovery plan for the Jarbidge River distinct population segment of bull trout (*Salvelinus confluentus*). Fish and Wildlife Service, Portland, Oregon. May 2004.132 pp +xiii.

U.S. Fish and Wildlife Service. 2004b. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Volume I: Puget Sound Management Unit, 389+xvii pp and Volume II: Olympic Peninsula Management Unit, Portland, Oregon. 277+xvi pp.

U.S. Fish and Wildlife Service. 2005. Bull trout core area template-complete core area by core area analysis. Fredenberg, W. and J. Chan (eds.). U.S. Fish and Wildlife Service, Portland, Oregon.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252.

Washington Department of Fish and Wildlife, FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. March 1997. Olympia, Washington.

In Litteris REFERENCES

Gilpin, M., University of California, San Diego. 1997. Bull trout connectivity on the Clark Fork River. Letter to Shelley Spalding, Montana Department of Fish, Wildlife and Parks, Helena, Montana.

PERSONAL COMMUNICATIONS

Gamett, B. 2002. U.S. Forest Service. Telephone conversation 06/20/02 with Shelley Spalding, U.S. Fish and Wildlife Service. (Subject: relationship between water temperature and bull trout distribution and abundance in the Little Lost River, Idaho.).

LITERATURE CITED (STATUS OF CRITICAL HABITAT)

Dunham, J.B., B.E. Rieman. 1999. Metapopulation Structure of Bull Trout: Influences of Physical, Biotic, and Geometrical Landscape Characteristics. 9:642-655.

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63: 133-143.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-326.

Healy, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-184.

Leary, R. F., F. W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7(4):856-865.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Report prepared for the Montana Bull Trout Restoration Team, Helena, MT.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-302, Ogden, Utah. 38 pp.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764.

Rieman, B. E., J. Peterson, and D. Meyers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull tout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences 63:63–78.

APPENDIX A

FRAMEWORK FOR ASSESSING SEDIMENT IMPACTS (2006)

The general impacts of sedimentation within an aquatic system are well known. When a biologist reviews a biological assessment or biological evaluation under section 7 of the Endangered Species Act, effects are evaluated based on the data or information provided. In most cases, specific information is not supplied by the action agency, or is not available for the biologist to conduct a thorough review and make that vital link between the project and the effect on listed fishes, specifically bull trout (*Salvelinus confluentus*) and their habitat.

Specific information needed by a biologist is related to the physical and biological effects of sediment in a stream. The physical questions include the following:

1. Will the project increase sediment input into the stream?
2. How much sediment will result and for what duration?
3. How far downstream will the sediment move?

Based on these physical questions, the biological effects to listed fish species can then be determined. The biological questions include the following:

1. What life stage(s) are affected by the sediment input?
2. What levels of sedimentation cause adverse effects?
3. What are the biological effects of sediment on fish and their habitat?

SEDIMENT CLASSIFICATIONS AND DEFINITIONS

Sediment within a stream can be classified into a variety of different categories: turbidity, suspended sediment, bedload, deposited sediment, and wash load (Waters 1995; Bash et al. 2001). A geomorphologist may classify sediment differently than a fisheries biologist. Sediment category definitions include:

- Turbidity - Optical property of water which results from the suspended and dissolved materials in the water that cause light to be scattered rather than transmitted in straight lines. Turbidity is measured in nephelometric turbidity units (NTUs). Measurements of turbidity can quickly estimate the amount of sediment within a sample of water.
- Suspended sediment - Represents the actual measure of mineral and organic particles transported in the water column. Suspended sediment is measured in mg/l and is an important measure of erosion, and is linked to the transport of nutrients, metals, and industrial and agricultural chemicals through the river system.
- Bedload - Consists of larger particles on the stream bottom that move by sliding, rolling, or saltating along the substrate surface. Bedload is measured in tons/day, or tons/year.

- Deposited sediment - The intermediate sized sediment particles that settle out of the water column in slack or slower moving water. Based on water velocity and turbulence, these intermediate size particles may be suspended sediment or bedload.
- Wash load - Finest particles in the suspended load that are continuously maintained in suspension by the flow turbulence, and thus, significant quantities are not found in the bed.

Suspended sediment, turbidity, and deposited sediment are not mutually exclusive as to particle size, because they will overlap considerably depending on velocity, turbulence, and gradient (MacDonald et al. 1991; Waters 1995). Turbidity cannot always be correlated with suspended solid concentrations due to the effects of size, shape and refractive index of particles (Bash et al. 2001). Turbidity and suspended sediment affect the light available for photosynthesis, visual capability of aquatic animals, gill abrasion and physiological effects to fish. Suspended and deposited sediment affect the habitat available for macroinvertebrates, quality of gravel for fish spawning, and amount of habitat for fish rearing (Waters 1995).

Particle size is also important. Particle diameters less than 6.4 mm are generally defined as "fines" (Bjornn et al. 1977; Bjornn and Reiser 1991; Shepard et al. 1984; Hillman et al. 1987; Chapman 1988; Reiman and McIntyre 1993; Castro and Reckendorf 1995; MBTRT 1998). The quantity of "fines" within a stream ecosystem is usually associated with the degradation of a fish population (Castro and Reckendorf 1995).

INFORMATION SOURCES

To determine the overall impact of a project on bull trout, and to specifically understand whether increased sediment may adversely affect bull trout, the biologist will need to review specific information relating to the watershed and stream in which the project is located.

The following documents are important to review:

1. Washington State Conservation Commission's Limiting Factors Analysis. The 1998 Washington State Legislative session produced a number of bills aimed at salmon recovery. One bill was to identify the limiting factors to salmonid populations within watersheds in Washington State. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon." Limiting factors analyses have been developed for numerous watersheds. The status of the limiting factors analyses for each Water Resource Inventory Area (WRIA) can be found at http://salmon.scc.wa.gov. The Endangered Species Division has final copies of completed documents.

2. Washington Department of Fish and Wildlife's (1998) Salmonid Stock Inventory (SaSI). The Washington Department of Fish and Wildlife (WDFW) inventoried bull trout and Dolly Varden (*S. malma*) stock status throughout the State. The intent of the inventory is to help identify available information and to guide future restoration planning and implementation. SaSI defines the stock within the watershed, life history

forms, status and factors affecting production. Spawning distribution and timing for different life stages are provided (migration, spawning, etc.), if known.

3. U.S. Fish and Wildlife Service's (USFWS 1998a) Matrix of Diagnostics/Pathways and Indicators (MPI). The MPI was designed to facilitate and standardize determination of project effects on bull trout. The MPI provides a consistent, logical line of reasoning to aid in determining when and where adverse affects occur and why they occur. The MPI provides levels or values for different habitat indicators to assist the biologist in determining the level of effects or impacts to bull trout from a project and how these impacts may cumulatively change habitat within the watershed.

4. Individual Watershed Resource Publications. Other resources may be available within a watershed that will provide information on habitat, fish species, and recovery and restoration activities being conducted. Local groups can provide valuable information specific to the watershed.

5. Washington State Department of Ecology (WDOE) Water Quality Database. The WDOE has long and short-term water quality data for different streams within the State. Data can be found at www.ecy.wa.gov/programs/eap/fw_riv/rv_main. Clicking on a stream or entering a stream name will provide information on current and past water quality data. This information will be useful for determining the specific turbidity/suspended sediment relationship for that stream (more information below).

6. WDOE Stream Conditions Database. The WDOE has also been collecting benthic macroinvertebrates and physical habitat data to describe conditions under natural and anthropogenic disturbed areas. Data can be found at www.ecy.wa.gov/programs/eap/fw_benth/93-98. Clicking on a stream or entering a stream name will provide habitat and macroinvertebrate data.

7. U.S. Forest Service (USFS) Watershed Analysis Documents. The USFS is required by the Record of Decision for Amendments to the USFS and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl to conduct a watershed analysis for watersheds located on USFS lands. The watershed analysis determines the existing condition of the watershed and makes recommendations for future projects that move the landscape towards desired conditions. Watershed analysis documents are available from individual National Forests or from the Western Washington Fish and Wildlife Office, Forest Plan Branch.

8. U.S. Fish and Wildlife Service Bull Trout Recovery Plans and Critical Habitat Designations. The draft Bull Trout Recovery Plan for the Coastal-Puget Sound Distinct Population Segment (DPS) and the final critical habitat designations provide current species status, habitat requirements, and limiting factors for bull trout within specific individual recovery units. These documents are available from the Western Washington Fish and Wildlife Office and the Service's web page (www.fws.gov).

These documents and websites provide information on stream and watershed conditions as of 2005. This information is critical to understanding baseline conditions and determining future sediment impacts to the aquatic system. A stream has a natural amount of sediment that is transported through the system. This amount of sediment is based on numerous factors: precipitation, topography, geology, streamflow, riparian vegetation, stream geomorphological characteristic, human disturbance, etc (Bash et al. 2001). However, baseline or background levels need to be analyzed with respect to the limiting factors within the watershed.

Different watersheds have different levels of turbidity or suspended sediment. A glaciated stream will have higher sediment levels than a spring-fed stream. Aquatic organisms are adapted to the natural variation in sediment load that occurs seasonally within their stream habitat. (ACMRR 1976; Birtwell 1999). Field experiments have found a thirty-fold increase in tolerance of fish to suspended solids between August and November when naturally occurring concentration are expected to be high (Cederholm and Reid 1987). The question at hand is whether additional input of sediment may result in increased bull trout impacts.

Sediment levels in excess of natural amounts can have multiple adverse effects on channel conditions and bull trout (Rhodes et al. 1994). The effect can be fatal at high levels. Low levels may result in sublethal effects such as loss or reduction of foraging capability, reduced growth, reduced resistance to disease, increased stress, and interference with orientation in homing and migration (McLeay et al 1987; Newcombe and McDonald 1991; Bash et al. 2001).

Work-timing windows are usually incorporated into projects to minimize construction impacts to fish. Work-timing windows are time periods when salmonids are at a stage in their life cycle when they are least sensitive to disturbances or are least likely to be present. This is typically outside of the spawning or egg incubating period. Work-timing windows allow the fish to either move away from impacts or to better cope with short term, minimal changes to the habitat and/or decreased water quality. The work-timing windows are usually in July through September. This time may reduce impacts to spawning fish and egg incubating periods, but may exacerbate impacts to juveniles, sub-adults, and adults. Protective mucous secretions are inadequate during the summer months, when natural sediment levels are low in a stream system, and thereby sediment introduction at this time may increase fish risk to stress and disease (Bash et al. 2001).

BIOLOGICAL EFFECTS OF SEDIMENT ON BULL TROUT

Classification of Sediment Effects

In the absence of detailed local information on population dynamics and habitat use, any increase in the proportion of fines in substrates should be considered a risk to the productivity of an environment and to the persistence of associated bull trout populations (Rieman and McIntyre 1993). Specific effects of sediment on fish and their habitat can be put into three classes that include (Newcombe and MacDonald 1991; Waters 1995; Bash et al. 2001):

Lethal: Direct mortality to any life stage, reduction in egg-to-fry survival, and loss of spawning or rearing habitat. These effects damage the capacity of the ecosystem to produce fish and future populations.

Sublethal: Reduction in feeding and growth rates, decrease in habitat quality, reduced tolerance to disease and toxicants, respiratory impairment, and physiological stress. While not leading to immediate death, may produce mortalities and population decline over time.

Behavioral: Avoidance and distribution, homing and migration, and foraging and predation. Behavioral effects change the activity patterns or alter the kinds of activity usually associated with an unperturbed environment. Behavior effects may lead to immediate death or population decline or mortality over time.

Environmental factors affecting sediment impacts on individual fish include duration of exposure, frequency of exposure, toxicity, temperature, life stage of fish, angularity and size of particle, severity/magnitude of pulse, time of occurrence, general condition of biota, and availability of and access to refugia (Bash et al. 2001). Aquatic systems are complex interactive systems, and isolating the effects of sediment on fish populations is difficult (Castro and Reckendorf 1995). Determining which environmental variables act as limiting factors has made it difficult to establish the specific effects of sediment impacts on fish populations (Chapman 1988). For example, excess fines in the spawning gravels may not lead to smaller populations of adults if the amount of juvenile winter habitat limits the number of juveniles that reach adulthood. Often there are multiple independent variables with complex inter-relationships that can influence population size.

The ecological dominance of a given species is often determined by environmental variables. A chronic input of sediment could tip the ecological balance in favor of one species in a mixed salmonid population, or in species communities composed of salmonids and nonsalmonids (Everest et al. 1987). Bull trout have more spatially restrictive biological requirements than other salmonids at both the individual and population levels (USFWS 1998b). Therefore, they are especially vulnerable to environmental changes such as sediment deposition.

Bull trout are apex predators that prey on a variety of species including terrestrial and aquatic insects and fish (Reiman and McIntyre 1993). Fish are common in the diet of individual bull trout that are over 110 millimeters or longer. Large bull trout can feed almost exclusively on fish. Therefore, when analyzing impacts of sediment on bull trout, it is very important to consider other fish species. While sediment may not directly impact bull trout, the increased sediment input may affect the spawning and population levels of Chinook and coho salmon, cutthroat trout, and steelhead, which are potential prey species for bull trout. The following effects of sediment are not just bull trout specific. All salmonids can be affected similarly.

Direct effects

Gill trauma

High levels of suspended sediment and turbidity can cause fish mortality by damaging and clogging gills. Fish gills are delicate and easily damaged by abrasive silt particles (Bash et al. 2001). As sediment begins to accumulate in the gill filaments, fish excessively open and close their gills to expunge the silt. If irritation continues, mucus is produced to protect the gill surface, which may impede the circulation of water over the gills and interfere with fish respiration (Bash et al. 2001). Gill flaring or coughing abruptly changes buccal cavity pressure and is a means of clearing the buccal cavity of sediment. Gill sediment accumulation may result when fish become too fatigued to continue clearing particles via the cough reflex (Servizi and Martens 1991).

Spawning, redds, eggs, and alevins

When suspended sediment deposits in a redd, it can reduce water flow, smothering eggs or alevins or impeding fry emergence, depending on the sediment particle sizes of the spawning habitat (Bjornn and Reiser 1991). Sediment particle size determines the pore openings in the redd gravel. With small pore openings, more suspended sediments are deposited and water flow is reduced compared to large pore openings.

Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Eggs and alevins are generally more susceptible than adults to stress from suspended solids. Accelerated sedimentation can reduce the flow of water and, therefore, oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Cederholm and Reid 1987; Chapman 1988; Bash et al. 2001), delay development of alevins (Everest et al. 1987), reduce growth and cause premature hatching and emergence (Birtwell 1999). Fry delayed in their timing of emergence are less able to compete for environmental resources than other fish that have undergone normal development and emergence (intra- or interspecific competition) (Everest et al. 1987).

Several studies have documented that fine sediment can reduce the reproductive success of salmonids. Natural egg-to-fry survival of coho salmon, sockeye and kokanee has been measured at 23, 23, and 12 percent, respectively (Slaney et al. 1977). Substrates containing 20 percent fines can reduce emergence success by 30-40 percent (MacDonald et al. 1991). A decrease of 30 percent in mean egg-to-fry survival can be expected to reduce salmonid fry production to extremely low levels (Slaney et al. 1977).

Although bull trout generally have a narrow, specific spawning habitat requirement and therefore, spawn in a small percentage of the stream habitat available to them (MBTRT 1998), they seem to be more tolerant of sedimentation during development and emergence than other salmonids. Survival of bull trout embryos through emergence appears to be unaffected when the percentage of fines comprise up to 30 percent of the streambed. However, at levels above 30 percent, embryo survival through emergence dropped off sharply with survival below 20 percent for substrates with 40 percent fine material (Shepard et al. 1984).

Indirect effects

Macroinvertebrates

Macroinvertebrates are a significant food source for salmonids. Turbidity and suspended solids can affect macroinvertebrates in multiple ways through increased invertebrate drift, feeding impacts, respiratory problems, and loss of habitat (Cederholm and Reid 1987). Salmonids favor certain groups of macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987; Waters 1995).

The effect of light reduction from turbidity has been well documented as increasing invertebrate drift (Waters 1995; Birtwell 1999). This may be a behavioral response associated with the night-active diel drift patterns of macroinvertebrates. While increased turbidity results in increased macroinvertebrate drift, it is thought that the overall invertebrate populations would not fall below the point of severe depletion (Waters 1995).

Increased suspended sediment can abrade the respiratory surface of macroinvertebrates and interfer with food uptake for filter-feeders (Birtwell 1999). Increased suspended sediment levels tend to clog feeding structures and reduce feeding efficiencies, which results in reduced growth rates, increased stress, or death of the invertebrates (Newcombe and MacDonald 1991). Invertebrates living in the substrate are also subject to scouring or abrasion which can damage respiratory organs (Bash et al. 2001).

Benthic invertebrates inhabit the stream bottom. Therefore, any modification of the streambed by deposited sediment will most likely have a profound effect upon the benthic invertebrate community (Waters 1995). Increased sediment can affect macroinvertebrate habitat by filling interstitial space and rendering attachment sites unsuitable. This may cause invertebrates to seek a more favorable habitat (Rosenberg and Snow 1975). The degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrate abundance and composition (Birtwell 1999). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995).

Feeding Efficiency

Increased turbidity and suspended sediment can affect salmonid feeding rates, reaction distance, and prey selection (Bash et al. 2001). Changes in feeding behavior are primarily related to the reduced visibility in turbid water. Effects on feeding ability are important as salmonids must meet energy demands to compete with other fishes for resources and to avoid predators.

Distance of prey capture and prey capture success both were found to decrease significantly when turbidity was increased (Berg and Northcote 1985). Waters (1995) states that the loss of visual capability, leading to reduced feeding, is one of the major sublethal effects of high suspended sediment. Increases in turbidity was reported to decrease the percentage of prey captured (Bash et al. 2001). At 0 NTUs, 100 percent of the prey items were consumed. At 20 to 60 NTUs, significant delay in the response of fish to prey was observed. At 10 NTUs, fish were frequently unable to capture prey species; at 60 NTUs, only 35 percent of the prey items were captured. Loss of visual capability and capture of prey leads to depressed growth and reproductive capability.

Sigler et al. (1984) found that a reduction in growth occurred in steelhead and coho salmon when turbidity was as little as 25 NTUs. The slower growth was presumed to be from a reduced ability to feed; however, other complex mechanisms, such as the quality of light, may also affect feeding success rates. Redding et al. (1987) found that suspended sediment may inhibit normal feeding activity, as a result of a loss of visual ability or as an indirect consequence of increased stress.

Habitat Effects

Compared to other salmonids, bull trout have more specific habitat requirements that appear to influence their distribution and abundance (Reiman and McIntyre 1993). All life history stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools. Other habitat characteristics important to bull trout include channel and hydrologic stability, substrate, temperature, and the presence of migration corridors (Reiman and McIntyre 1993).

The physical effects of sediment in streams include degradation of spawning and rearing habitat, simplification and damage to habitat structure and complexity, loss of habitat, and decreased connectivity between habitat (Bash et al. 2001). Biological implications of this habitat damage include underutilization of stream habitat, abandonment of traditional spawning habitat, displacement of fish from their habitat, and avoidance of habitat (Newcombe and Jensen 1996).

As sediment enters a stream, it is transported downstream under normal fluvial processes and deposited in areas of low shear stress (MacDonald and Ritland 1989). These areas are usually behind obstructions, near banks (shallow water) or within interstitial spaces. This episodic filling of successive storage compartments continues in a cascading fashion downstream until the flow drops below the threshold required for movement or all pools have reached their storage capacities (MacDonald and Ritland 1989). As sediment load increases, the stream compensates by geomorphologic changes in increased slope, increased channel width, decreased depths, and decreased flows (Castro and Reckendorf 1995). These processes, in turn, contribute to increased erosion and sediment deposition which further degrade salmonid habitat.

Loss of acceptable habitat and refugia, as well as decreased connectivity between habitat reduces the carrying capacity of streams for salmonids (Bash et al. 2001). In systems lacking adequate number, distribution, and connectivity of habitat, fish may travel longer distances or use less desirable habitat and may encounter a variety of other conditions that can increase biological demands.

The addition of fine sediment (less than 6.4 mm) to natural streams during summer decreased abundance of juvenile Chinook salmon in almost direct proportion to the amount of pool volume lost to fine sediment (Bjornn et al. 1977; Bash et al. 2001). Similarly, the inverse relationship between fine sediment and densities of rearing Chinook salmon indicate how high sediment loads effect important winter habitat (Bjornn et al. 1977). As fine sediments filled the interstitial spaces between the cobble substrate, juvenile Chinook salmon were forced to leave preferred habitat and to utilize cover that may be more susceptible to ice scouring, predation, and decreased food availability (Hillman et al. 1987). Deposition of sediment on substrate may lower winter carrying capacity for bull trout (Shepard et al. 1984). Food production in the form of aquatic invertebrates may also be reduced.

Juvenile bull trout densities are highly influenced by substrate composition (Shepard et al. 1984; Reiman and McIntyre 1993; MBTRT 1998). During the summer, juvenile bull trout hold positions close to the stream bottom and often seek cover within the substrate itself. When streambed substrate contains more than 30 percent fine materials, juvenile bull trout densities drop off sharply (Shepard et al. 1984). Any loss of interstitial space or streambed complexity through the deposition of sediment would result in a loss of summer and winter habitats (MBTRT 1998). The reduction in rearing habitats ultimately reduces the potential number of recruited juveniles and ultimately reduces population numbers (Shepard et al. 1984).

Although fish avoidance in response to increased sediment may be an initial adaptive survival strategy, displacement from cover could be detrimental. The possible consequences of fish moving from preferred habitat to avoid increasing levels of suspended sediment may not be beneficial if displacement is to sub-optimal habitat, where they also become stressed and more vulnerable to predation (Birtwell 1999).

Physiological Effects

Sublethal levels of suspended sediment may cause undue physiological stress to fish, reducing the ability of the fish to perform vital functions (Cederholm and Reid 1987). At the individual fish level, stress can reduce growth, increase disease, and reduce the ability to tolerate additional stress (Bash et al. 2001). At the population level, the effects of stress may include reduced spawning success, increased larval mortality, reduced recruitment to succeeding life stages and, therefore, overall population declines (Bash et al. 2001).

Tolerance to suspended sediment may be the net result of a combination of physical and physiological factors related to oxygen availability and uptake by fish (Servizi and Martens 1991). The energy needed to perform repeated coughing (see Gill trauma section) increases metabolic oxygen demand. Metabolic oxygen demand is related to water temperature. As temperatures increase, so does metabolic oxygen demand, but the concentration of oxygen available in the water decreases. Therefore, fish tolerance of suspended sediment may be primarily related to the capacity of the fish perform work associated with the cough reflex. However, as sediment increases, fish have less capability to do work, and therefore less tolerance for suspended sediment (Serizi and Martens 1991).

Redding et al. (1987) observed higher mortality in young steelhead trout exposed to a combination of suspended sediment (2500 mg/l) and a bacterial pathogen, than when exposed to the bacteria alone. Physiological stress in fishes appears to decrease immunological competence, growth, and reproductive success (Bash et al. 2001).

Behavioral effects

Increased turbidity and suspended sediment may also cause behavior changes in salmonids. Avoidance, distribution, and migration may be affected. Many behavioral effects result from changes in stream habitat as well (see Habitat effects section). As suspended sediment concentration increases, habitat may be lost which results in abandonment and avoidance of preferred habitat. Stream reach emigration is a bioenergetic demand that may affect the growth or reproductive success of the individual fish (Bash et al. 2001). Sediment pulses result in downstream migration of fish, which disrupts social structures, and causes downstream displacement of other fish (McLeay et al 1987; Bash et al. 2001). Loss of territoriality and the breakdown of social structure can lead to secondary effects of decreased growth and feed rates, which may lead to mortality (Berg and Northcote 1985; Bash et al. 2001).

To the contrary, when not motivated by excess sediment, downstream migration by bull trout can provide access to more prey, better protection from avian and terrestrial predators, and alleviate potential intraspecific competition or cannibalism in rearing areas (MBTRT 1998). Benefits of migration from tributary rearing areas to larger rivers or estuaries may be increased growth potential. Increased sedimentation may result in premature or early migration of both juveniles and adults, or avoidance of habitat and migration of nonmigratory resident bull trout. Such migration exposes fish to many new hazards, including passage of sometimes difficult and unpredictable physical barriers, increased vulnerability to predators, exposure to introduced species, exposure to pathogens, and the challenges of new and unfamiliar habitats (MBTRT 1998).

Table 1 – Scale of the severity (SEV) of ill effects associated with excess suspended sediment.

SEV	Description of Effect
	Nil effect
0	No behavioral effects
	Behavioral effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal effects
4	Short-term reduction in feeding rates; short-term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Lethal and paralethal effects
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to sever habitat degradation
11	> 20 – 40% mortality
12	> 40 – 60% mortality
13	> 60 – 80% mortality
14	> 80 – 100% mortality

High turbidity can also delay migration back to spawning sites, although turbidity alone does not seem to affect homing. Delays in spawning migration and associated energy expenditure may reduce spawning success and therefore population size (Bash et al. 2001).

EFFECTS DETERMINATION

The point at which adverse effects to fish occur from a specific project can be difficult to determine without adequate data. There are numerous variables that affect the determination, and for which data may be unavailable. These include project specific sediment input, existing sediment conditions, stream conditions (velocity, depth, etc.) during construction, weather or climate conditions (precipitation, wind, etc.), fish presence or absence (bull trout plus prey species), effectiveness of the best management practices employed, plus many others.

The Western Washington Fish and Wildlife Office (WWFWO) is currently drafting protocol to obtain specific project related sediment data. This protocol will be used to identify project related sediment input during construction, as well as long-term sedimentation that may result after completion of the project (i.e. high-flow events, channel adjustments, etc.). Following the protocol will provide consistent information on project-related sediment input to assist in evaluating effects and quantifying incidental take in biological opinions.

Newcombe and Jensen (1996) provide a basis for determining when a project will be "likely to adversely affect" bull trout. They conducted a literature review of pertinent documents on sediment effects to salmonids and nonsalmonids, and developed a model that calculated the severity of effect (SEV) based on the suspended sediment dose (exposure) and concentration.

A 15-point scale is used to qualitatively rank the effects of sediment on fish (Table 1). Specific SEV levels will be used to determine when a project is "likely to adversely affect" bull trout.

The following procedure will be used:

1. Select either a. or b. below.

a. Based on water quality monitoring data, determine the amount of sediment and the duration of sediment input into the stream. (Currently not enough data are available to use this step. As more project specific data becomes available this step will be used).

b. Use State water quality standards. Because action agencies must meet State water quality standards you can use the standard for determining sediment input into the stream. The Washington State water quality standards for turbidity are provided in Table 2.

The State water quality standard allows for a mixing zone downstream of the project site. The point of compliance is based on stream discharge (Table 3).

The water quality standard must be converted from turbidity (NTUs) to suspended solids (mg/l). A ratio of 1:1 to 1:5 has been derived for converting turbidity to suspended solids (Birtwell

1999). Washington Department of Ecology or U.S. Geological Survey data should be used to determine specific turbidity:suspended solid ratios for the stream on which the project will be conducted (see Documents and Background Information section). If site specific ratios can not be determined use worse case ratio of 1:4 or 1:5.
2. Based on the background information gathered, determine what life stage(s) of bull trout will be affected by sedimentation (see Documents and Background Information section). Use Figures 1 through 4 to determine what SEV level will result for the life stage affected by the project.

3. Use Table 4 to determine what ESA determination is made for the life stage affected.

4. If a LAA determination is made, then the basis for the rationale for "take" occurring is based on the SEV value obtained. The rationale is not just for that specific level (SEV = 6), but includes previous SEVs as well.

5. Table 5 summarizes the project-specific water quality monitoring data received by the Service for individual projects and indicates that, in some cases, adverse effects that rise to the level of "incidental take" may occur up to at least 600 feet downstream of project locations. Water quality monitoring data can indicate, by analogy, typical levels of sediment impacts for different project types, and can be used to estimate the minimum extent of impact. The data include the distance from the project where water quality sampling occurred and the maximum NTU levels were observed. Additional monitoring data will be incorporated when available.

Table 2 - Turbidity water quality standards for various classes of surface waters in the State of Washington.

Washington State Classes for Surface Waters	**Turbidity Characteristic**
Class AA (extraordinary)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU.
Class A (excellent)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU
Class B (good)	Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 20 percent increase in turbidity when the background turbidity is > 50 NTU

Table 3 - Turbidity mixing zones for turbidity water quality standards.

Waterbody Type	Point of Compliance
Stream:	
≤ 10 cfs Stream Flow at Time of Construction	100 ft downstream of activity causing turbidity exceedance
>10 cfs up to 100 cfs Stream Flow at Time of Construction	200 ft downstream of activity causing turbidity exceedance
> 100 cfs Stream Flow at Time of Construction	300 ft downstream of activity causing turbidity exceedance

Figure 1 - Severity-of-ill-effect scores for juvenile and adult salmonids.

Juvenile and Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)	Hours			Days			Weeks		Months		
	1	3	7	1	2	6	2	7	4	11	30
162755	10	11	11	12	12	13	14	14	-	-	-
59874	9	10	10	11	12	12	13	13	14	-	-
22026	8	9	10	10	11	11	12	13	13	14	-
8103	8	8	9	10	10	11	11	12	13	13	14
2981	7	8	8	9	9	10	11	11	12	12	13
1097	6	7	7	8	9	9	10	10	11	12	12
403	5	6	7	7	8	9	9	10	10	11	12
148	5	5	6	7	7	8	8	9	10	10	11
55	4	5	5	6	6	7	8	8	9	9	10
20	3	4	4	5	6	6	7	8	8	9	9
7	3	3	4	4	5	6	6	7	7	8	9
3	2	2	3	4	4	5	5	6	7	7	8
1	1	2	2	3	3	4	5	5	6	7	7

Figure 2 - Severity-of-ill-effect scores for adult salmonids.

Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)	1 Hours	3 Hours	7 Hours	1 Days	2 Days	6 Days	2 Weeks	7 Weeks	4 Months	11 Months	30 Months
162755	11	11	12	12	13	13	14	14	-	-	-
59874	10	10	11	11	12	12	13	13	14	14	-
22026	9	10	10	11	11	12	12	13	13	14	14
8103	8	9	9	10	10	11	11	12	12	13	13
2981	8	8	9	9	10	10	11	11	12	12	13
1097	7	7	8	8	9	9	10	10	11	11	12
403	6	7	7	8	8	9	9	10	10	11	11
148	5	6	6	7	7	8	8	9	9	10	10
55	5	5	6	6	7	7	8	8	9	9	9
20	4	4	5	5	6	6	7	7	8	8	9
7	3	4	4	5	5	6	6	7	7	7	8
3	2	3	3	4	4	5	5	6	6	7	7
1	2	2	3	3	4	4	5	5	5	6	6

Figure 3 - Severity-of-ill-effect scores for juvenile salmonids.

Juvenile Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	9	10	11	11	12	13	14	14	-	-	-
59874	9	9	10	11	11	12	13	14	14	-	-
22026	8	9	9	10	11	11	12	13	13	14	-
8103	7	8	9	9	10	11	11	12	13	13	14
2981	6	7	8	9	9	10	11	11	12	13	13
1097	6	6	7	8	9	9	10	11	11	12	13
403	5	6	6	7	8	9	9	10	11	11	12
148	4	5	6	6	7	8	9	9	10	11	11
55	4	4	5	6	6	7	8	8	9	10	11
20	3	4	4	5	6	6	7	8	8	9	10
7	2	3	4	4	5	6	6	7	8	8	9
3	1	2	3	4	4	5	6	6	7	8	8
1	1	1	2	3	4	4	5	6	6	7	8
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 4 - Severity-of-ill-effect scores for eggs and alevins of salmonids.

Eggs and Alevins of Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	7	9	10	11	12	13	14	-	-	-	-
59874	7	8	9	10	12	13	14	-	-	-	-
22026	7	8	9	10	11	12	13	-	-	-	-
8103	7	8	9	10	11	12	13	14	-	-	-
2981	6	7	8	10	11	12	13	14	-	-	-
1097	6	7	8	9	10	11	12	14	-	-	-
403	6	7	8	9	10	11	12	13	14	-	-
148	5	6	7	9	10	11	12	13	14	-	-
55	5	6	7	8	9	10	12	13	14	-	-
20	5	6	7	8	9	10	11	12	13	-	-
7	4	5	7	8	9	10	11	12	13	14	-
3	4	5	6	7	8	10	11	12	13	14	-
1	4	5	6	7	8	9	10	11	13	14	-
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Table 4 - ESA Effect calls for different bull trout life stages in relation to the duration of effect and severity-of-ill-effect.

Life Stage	SEV	ESA Effect Call
Egg/alevin	1 to 4 5 to 14	not applicable - alevins are still in gravel and are not feeding. LAA - any stress to egg/alevin reduces survival
Juvenile	1 to 4 5 to 14	NLAA LAA
Subadult and Adult	1 to 5 6 to 14	NLAA LAA

Table 5 - Water quality monitoring data received by the Western Washington Fish and Wildlife Office showing distance downstream where data were recorded and the maximum magnitude of turbidity observed.

Project	Distance downstream from project that data were recorded	Distance downstream that State water quality standards are met, or the maximum turbidity levels observed.
Debris jam removal (SR - 20)	Not provided	Met standard
Rock placed in stream (Hoh River emergency bank protection)	100 feet - 200 feet	Met standard
Bridge construction (SR - 90) Stated removal of coffer dams and diversion resulted in increased turbidity.	Not provided	Maximum daily magnitude measured: 25 NTUs over standard.
River scour protection (SR 12) Contract no. C-6186	300 feet and 600 feet	Maximum daily magnitude measured: 9.3 NTUs over standard.
Bridge construction	200 feet	Maximum daily magnitude measured: 169 NTUs.
Culvert replacement project not described (SR241) - Contract # 6270 - Sulfur Cr.	100 feet and 200 feet	Maximum daily magnitude measured: over 30 NTUs.
Bank stabilization (Saxon Cr.)	300 feet	Maximum daily magnitude measured: 35.2 NTUs over standard.
Culvert replacement – (Stossel Cr Way.)	Not provided	Maximum daily magnitude measured: 24 NTUs over background.
Culvert Replacement – (Stevens Creek)	178 feet and 576 feet	Maximum daily magnitude measured: 185 NTUs over background.
Culvert Replacement – (Sunbeam Creek)	72 feet and 147 feet	Maximum daily magnitude measured: 454 NTUs over background.
Culvert Replacement – (Unnamed Waddell Creek Tributary)	62 feet	Maximum daily magnitude measured: 600 NTUs over background.

LITERATURE CITED

ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources. 1976. Indices for measuring responses of aquatic ecological systems to various human influences. Food and Agriculture Organization of the United Nations, Fisheries Technical Paper 151, Rome, Italy.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington, November 2001.

Berg, L., and TG Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon *(Oncorhynchus kisutch)* following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Birtwell, Ian K. 1999. The Effects of Sediment on Fish and Their Habitat. Canadian Stock Assessment Secretariat Research Document 99/139.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt, E. Chacho, and C. Schaye. 1977. Transport of granitic sediment in streams and its effects on insects and fish. University of Idaho, Idaho cooperative Fisheries Research Unit, Completion Report, Project B-036-IDA, Bulletin 17. Moscow.

Bjornn, TC, and DW Reiser. 1991. Habitat requirement of salmonids in streams. Pages 83-138. In: Influences of forest and rangeland management on salmonid fishes and their habitats. Editor: Meehan WR. American Fisheries Society Special Publication 19.

Castro, J., and Reckendorf, F. 1995. RCA III: effects of sediment on the aquatic environment; potential NRCS actions to improve aquatic habitat. Natural Resources Conservation Service, Oregon State University, Department of Geosciences.

Cederholm, C.J. and L.M. Reid. 1987, Impact of Forest Management on Coho Salmon (*Oncoryhynchus isutch*) Populations of the Clearwater River, Washington: a Project Summary. Pages 373-398 in Salo, E.O., and T.W. Cundy, editors. Streamside Management: Forestry and Fishery Interactions. University of Washington Institute of Forest Resources Contribution 57.

Chapman, D.W. 1988. Critical Review of Variable Used to Define Effects of Fines in Redds of Large Salmonids. Transactions of the American Fisheries Society. 117:1-21.

Everest, F.H., R.L. Beschta, J.C. Scrivener, K.v Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine sediment and salmonid production: a paradox. Pages 98-142 in Salo, E.O., and T.W. Cundy, editors. 1987. Streamside management: forestry and fishery interactions. University of Washington Institute of Forest Resources Contribution 57.

Hillman, TW., JS Griffith, and WS Platts. 1987. Summer and winter habitat selection by juvenile Chinook salmon in a highly sedimented Idaho stream. Transactions of the American Fisheries Society 116:185-195.

MacDonald, A. and K.W. Ritland. 1989. Sediment Dynamics in Type 4 and 5 Waters, A Review and Synthesis. Timber Fish and Wildlife. TFW-012-89-002.

MacDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. Monitoring guidelines to evaluate the effects of forestry activities on stream in the Pacific Northwest and Alaska. Region 10, U.S. Environmental Protection Agency. EPA 90/9-91-001.

McLeay, DJ., IK Birtwell, GF Hartman, and GL Ennis. 1987. Responses of Arctic grayling (*Thymallus arcticus*) to acute and prolonged exposure to Yukon placer mining sediment. Canadian Journal of Fisheries and Aquatic Sciences 44:658-673.

Montana Bull Trout Restoration Team. 1998. The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout. C/o Montana Fish, Wildlife and Parks. Helena Montana.

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11:72-82.

Newcombe, CP and JOT Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16:693-727.

Redding, JM., CB Screak, and FH Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the American Fisheries Society 116:737-744.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. U.S. Forest Service, General Technical Report INT-302. Intermountain Research Station, Boise, ID.

Rhodes, Johnathan J., Dale A. McCullough, and F. AL Espinosa, Jr. 1994. A coarse screening process for evaluation of the effects of land management activities on salmon spawning and rearing habitat in ESA consultations. Technical Report 94-4. National Marine Fisheries Service, Portland Oregon. 245 pp.

Rosenberg, DM, and NB Snow. 1975b. A design for environmental impact studies with special reference to sedimentation in aquatic systems of the Mackenzie and Porcupine river drainages. Pages 65-78 in Proceedings of the circumpolar conference on northern ecology. National Research Council of Canada, Ottawa.

Servizi, JA, and DW Martens. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon (*Oncorhynchus kisutch)*. Canadian Journal of Fisheries and Aquatic Sciences 48: 493-497.

Shepard, BB, SA Leathe, TM Waver, and MD Enk. 1984 or 1985? Monitoring levels of fine sediment within tributaries to Flathead Lake, and impacts of fine sediment on bull trout recruitment. Pages 146-156 in F. Richardson and R.H Hamre, editors. Wild trout III. Federation of Fly Fishers and Trout Unlimited, Vienna, Virginia.

Sigler, JW, TC Bjornn, and FH Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113:142-150.

Slaney, PA, TG Halsey, and AF Tautz. 1977. Effects of forest harvesting practices on spawning habitat of stream salmonids in the Centennial Creek watershed, British Columbia. British Columbia Ministry of Recreation and Conservation, Fish and Wildlife Branch, Fisheries management Report 73, Victoria.

U.S. Fish and Wildlife Service. 1998a. A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. Western Washington Fish and Wildlife Office, Lacey, WA. 45pp.

U.S. Fish and Wildlife Service. 1998b. Bull trout interim conservation guidance. Western Washington Fish and Wildlife Office, Lacey, WA. 47pp.

Washington Department of Fish and Wildlife. 1988. 1998 Washington Salmonid Stock Inventory. Appendix. Bull Trout and Dolly Varden. July 1998.

Waters, Thomas F., 1995. *Sediment in Streams: Sources, Biological Effects, and Control.* American Fisheries Society Monograph